Volume 24, Number 12 June 30, 1970

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 22665, 22878, and 23424.

22574 (NBS-SPEC-PUBL-310) NUCLEAR STANDARDS FOR CHEMISTRY AND TECHNOLOGY. NUCLEAR STANDARDS FOR INDUSTRY, SCIENCE, GOVERNMENT, AND CONSUMER. Proceedings of a Symposium held at the 156th National Meeting of the American Chemical Society, Atlantic City, New Jersey, September 8-9, 1968. Beeghly, H. F.; Cali, J. P.; Meinke, W. W. (eds.) (National Bureau of Standards, Washington, D. C.). Dec 1968. 256p. (CONF-680918). GPO $1.25.

The Symposium sponsored by the American Chemical Society Division of Nuclear Chemistry and Technology in cooperation with the Committee on Standardization Relations brought together most of the groups with interests in standards for nuclear chemistry and technology to identify the problems, to discuss present programs, and to outline future needs for standards in this field. Standards for purposes of the symposium were defined very broadly to include standard materials, standard procedures, standard specifications, standard data, and engineering standards. The mechanisms available for standardization, the "state of the art" in standardization in many areas of the nuclear field, some indications of unmet needs, and estimates of future needs were discussed in a series of papers and panel discussions that are presented here in either complete or summary form. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 23346, 23433, and 23481.

22575 (AEC-tr-6979) ATOMIC ABSORPTION SPECTROSCOPY. L'vov, B. V. Translation of Atomno-Absorbtsionnyi Spektral'nyi Analiz, Izdatel'stvo Nauka, Moscow, 1966. 251p. (TT-69-55015; IPST-Cat.-5404). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 14170.

22576 (ANL-Trans-796) SEMI-ANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY, JUNE-NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 1, pp 5-80 of report CEA-N-1148. 78p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 11423.

22577 (FOA-4-4407) ON THE SEPARATION AND DETERMINATION OF FLUORINE. 5. DETERMINATION OF 0.5-7 MICROMOLES FLUORINE (AND 0.3-4 MICROMOLES CHLORINE) IN PLUTONIUM METAL BY PYROHYDROLYSIS AND SPECTROPHOTOMETRIC ANALYSIS. Andersson, L-H.; Gelin, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jan 1970. 9p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

A method is described for determining 0.5 to 7 micromoles fluorine and 0.3 to 4 micromoles chlorine in plutonium metal by pyrohydrolysis and spectrophotometric analysis. An apparatus for pyrohydrolytic separation enclosed in a glove-box is described. The sample was heated to about 900°C in a flow of argon gas saturated with steam. The metal was oxidized and the halogens from hydrogen halides are, with the argon gas, brought down into a receiver containing dilute alkali solution. The fluoride and chloride ions are determined spectrophotographically in this solution. The best samples were 0.2 to 0.5 g plutonium metal. The standard deviation was 0.4 for both fluorine and chlorine. (Sweden)

22578 (FOA-4-4409) DETERMINATION OF NITROGEN AS A NITRATE IN RADIOACTIVE WASTES. Andersson, L-H.; Gelin, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jan 1970. 7p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

A method was developed for determining nitrogen as nitrate in paper waste and in liquid waste from glove boxes designed for work with alpha active material. The nitrogen is transformed to ammonia by reduction in alkali solution. The paper waste is first decomposed by boiling in lye. The ammonia is transferred to a boric acid solution in a microdiffusion cell and is determined spectrophotometrically. In solutions containing about 5 micrograms nitrogen the standard deviation for the determination was 0.2 micrograms. In solid samples of the order of 1 gram the analysis limit was found to be 0.3 mg of nitrogen. The method described satisfies given limited conditions. (auth) (Sweden)

22579 EXCHANGE REACTIONS OF TERNARY ION-ASSOCIATION COMPLEXES DIRECTLY IN THE ORGANIC PHASE. Burke, R. W. (National Bureau of Standards, Washington, D. C.). Talanta; 17: 240-2(Mar 1970).

A new approach has been developed that combines the advantages of solvent extraction with the inherently high sensitivities afforded through the incorporation of large organic dye cations into ternary ion-association complexes containing the metal ion of interest. Basically, the new technique involves the formation of a complex, $[ML_x^-]R^+$, where R^+ initially is either a non-coloured or a non-fluorescent organic cation. Following extraction of $[ML_x^-]R^+$ a second cation, R_1^+, which is capable of exchanging with the first R^+ group, is added directly to the organic phase. In this instance, however, R_1^+ is purposely selected to be highly coloured or fluorescent, thereby yielding the highly coloured or fluorescent complex $[ML_x^-]R_1^+$. Unreacted R_1^+ is readily back-extracted, leaving only the dye-complex in the organic phase. The determinations of gold and uranium are described to illustrate the advantages of the new technique. (auth) (UK)

22580 DETERMINATION OF URANIUM IN ROCKS BY CATHODE-RAY POLAROGRAPHY. Hetman, J. S. (SPNA, Pau, France). Bull. Cent. Rech, Pau, 2: 465-70(1968). (In French).

The sample (1 g) is treated with HNO_3 (5 ml) and $HClO_4$ (15 ml) to destroy organic matter, then the solution is evaporated to ~5 ml. This solution, together with the insoluble residue, is evaporated to dryness after the addition of HF (20 ml), and 1.5N-HNO_3 (20 ml), is added to the residue; if the solution is not clear, $HClO_4$ (2 ml) is added, and the mixture is again evaporated to dryness. Molybdenum is extracted into benzoin α-oxime solution in $CHCl_3$, and U is then extracted into tributyl phosphate solution in cyclohexane and is re-extracted into ammonium carbonate solution. This solution is evaporated to dryness and heated to destroy any organic matter, and the residue is dissolved in aqua regia (1 ml) and evaporated. The residue is dissolved in 5% ascorbic acid solution, and the solution is de-oxygenated before the polarographic determination of U at −0.35 V vs the S.C.E. Results are reproducible for 3 to 50 ppM of U. (Anal. Abstr.)

22581 AMPEROMETRIC DETERMINATION OF URANIUM AS TELLURITE. Deshmukh, G. S.; Rao, V. S. Sankara (Banaras Hindu Univ., India). Curr. Sci. (India); 39: 181-2(20 Apr 1970).

A procedure was developed for estimation of U(VI) amperometrically using sodium tellurite as titrant. (M.C.G.)

22582 DETERMINATION OF NATURAL URANIUM IN BIOSUBSTRATES BY MEANS OF AN EXPRESS (DIRECT) METHOD. Sadikova, N. M.; Polonskaya, E. K.; Golutvina, M. M. Med. Radiol.; 15: No. 2, 65-9(Feb 1970). (In Russian).

The method of determining uranium in the urine is based on the thermic destruction of small quantities of the urine (1 ml), fusion of remnants with a fluoride mixture, and evaluation of the activity of the alloy fluorescence. The sensitivity of the method is 3×10^{-9} g/l of urine; the loss coefficient is 1.0 ± 0.15. The method is simple and therefore is suitable for serial investigations. The possibility of using direct instrumental methods for determining the uranium content in the feces and tissues is discussed. The values of coefficients of losses, the sensitivity, and accuracy of determination are given. (auth)

22583 SOME PROBLEMS IN THE ANALYSIS OF AUGER ELECTRON SPECTRA. Haas, T. W.; Grant, J. T.; Dooley III, G. J. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Vac. Sci. Technol.; 7: 43-5(Jan-Feb 1970).

From 16th National Vacuum Symposium, Seattle, Wash. See CONF-691006.

Auger electron spectroscopy has been used to determine common impurities found on the transition metals Sc, Ti, V, Cr, Fe, Co, Ni, Y, Zr, Nb, Mo, Ru, Rh, La, Hf, Ta, W, Re, Ir, Pt, and Au. Single crystal and polycrystal specimens were used, with both specimen types giving similar results. The most prevalent impurity on most of these surfaces was not carbon as had been previously supposed but rather was sulfur. Mild heat treatment caused sulfur to segregate at the surfaces of these materials, while more drastic heating, to 1000°C or greater, will normally remove all the sulfur. Clean Mo surfaces exhibited a peak in the Auger spectrum at 150 V, the location of the sulfur peak, but arguments are given to suggest that this peak is characteristic of the clean rather than the contaminated surface. Observations of chemical shifts in Auger spectra have been made and are also discussed. (auth)

22584 USE OF TETRACYANOPLATINATE(II) FOR THE LUMINESCENT DETECTION OF METAL IONS. Capelin, B. C.; Ingram, G. (Portsmouth Polytechnic, Eng.). Talanta; 17: 187-95(Mar 1970). (CONF-690718-1).

The tetracyanoplatinate(II) (TCP) ion forms insoluble fluorescent compounds with many metal ions. This property has not hitherto been exploited for analytical use. The soluble sodium TCP salt has been applied as a reagent for metal ion detection. Fluorescent precipitates useful for detection of the metal ions were obtained with Y(III), Zr(IV), Ag(I), Zn(II), Cd(II), Hg(I), Hg(II), Al(III), Pb(II), La(III), and Th(IV). Limits of detection ranged from 5 to 200 ppM. With ammonium acetate as a masking agent, selective detection of 10 ppM of silver was achieved in the presence of the other metal ions. As little as 20 ppM of zirconium can be detected in the presence of hafnium, which yields a nonfluorescent precipitate. (auth) (UK)

22585 ISOTOPIC ANALYSIS OF NITROGEN BY MEANS OF OPTICAL SPECTROSCOPY. Constantinescu, Ligia; Ungureanu, C. (Inst. of Atomic Physics, Cluj). Stud. Cercet. Fiz.; 21: 641-59(1969). (In Rumanian).

Analytical methods based on optical spectroscopy for isotopic determination were developed for determining the isotopic composition of nitrogen, using instruments of intermediate resolution for determining the equilibrium established in the discharge tube on the basis of the reaction $2\ ^{14}N\ ^{15}N \rightleftharpoons {}^{14}N_2 + {}^{15}N_2$. The isotopic shift of the bands of the electronic vibrational spectrum and of the rotational lines of nitrogen molecules was used as analytical criteria. The method requires the photographic recording and determination of the blackening of the lines; by varying the exposure, equal blackening may be obtained. The errors are due to the dimensional changes of the plates, resolution, and superposition of the rotational lines of neighboring bands. In view of the importance of nitrogen for physical, chemical, medical, agricultural, and other studies, the availability of this relatively simple technique for determining its isotopic composition is of great importance. (TTT)

22586 STRONTIUM ISOTOPES IN QUATERNARY BASALTS OF THE SOUTHEASTERN CALIFORNIA. Peterman, Zell E. (Geological Survey, Denver); Carmichael, I. S. E.; Smith, A. L. Earth Planet Sci. Lett.; 7: 381-4(Feb 1970).

Strontium isotopic variations ($^{87}Sr/^{86}Sr$ of 0.7029 to 0.7052) in quaternary basalts of southeastern California, USA, are not readily explained by assimilation of crustal material similar to that contained as xenoliths in the basalt. Isotopic differences between chrome diopside (0.7016) and olivine (0.7087) from a lherzolite xenolith suggest that the isotopic variations in the basalts may be inherited from the source regions or modified by the upper parts of the mantle that were traversed by the lavas. (auth)

22587 DETERMINATION OF PHOSPHORUS IN NIOBIUM, ZIRCONIUM, TITANIUM, AND TUNGSTEN. Pakalns, P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Anal. Chim. Acta; 50: 103-8(Apr 1970).

A method is described for the spectrophotometric determination of up to 0.08% phosphorus in niobium, zirconium, titanium, and tungsten and their alloys, based on the extraction of phosphovanadomolybdate by isobutyl methyl ketone. The matrix metals are complexes by fluoride ion and do not interfere in the procedure. The molar absorptivity is 1740 and 3100 at 425 and 400 nm, respectively, with a standard deviation of ±0.5%. (auth)

22588 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM(III) WITH 5,7-DICHLORO-, 5,7-DIBROMO- AND 5,7-DINITRO-8-HYDROXYQUINOLINE N-OXIDE. Gupta, R. D.; Manku, G. S.; Bhat, A. N.; Jain, B. D. (Univ. of Delhi). Anal. Chim. Acta; 50: 109-16(Apr 1970).

The deeply colored 1:1 and 1:2 (metal:ligand) complexes of ruthenium(III) with 5,7-dichloro-8-hydroxyquinoline N-oxide (I), 5,7-dibromo-8-hydroxyquinoline N-oxide (II) and 5,7-dinitro-8-hydroxyquinoline N-oxide (III) were investigated spectrophotometrically in 60% acetone medium, and are suggested for the spectrophotometric determination of ruthenium(III) in presence of other platinum metals. The stability constants ($\log \beta_1$ and $\log \beta_2$) (determined spectrophotometrically) decrease in the order II > I > III, which is the same as that of the basicity of the ligands. (auth)

22589 DETERMINATION OF NIOBIUM IN ZIRCONIUM–NIOBIUM ALLOY BY HYDROGEN PEROXIDE PHOTOMETRIC METHOD. Hashitani, Hiroshi; Yoshida, Hideyo (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 19: 403-6(Mar 1970). (In Japanese).

The analytical results in 12 laboratories for 4 samples of fluorescent x-ray standards showed that the precisions in coefficient of variation (%) were 1.8, 1.3, 2.1, and 3.9, respectively, for 3.95, 2.63, 1.69, and 1.38% of niobium. The sample containing 2 to 4 mg of niobium was dissolved by heating with ammonium sulfate (10 g), sulfuric acid (20 ml) and perchloric acid (2 ml). After dissolution, perchloric acid was expelled, and the solution was made up to 50 ml with sulfuric acid in a volumetric flash. Exactly 25 ml of the solution was transferred to another 50 ml flask, and 5 ml of hydrogen peroxide–sulfuric acid (20 ml of 30% hydrogen peroxide and 480 ml of sulfuric acid) was added. Both solutions in two volumetric flasks were made up to 50 ml with sulfuric acid, and the absorbance of that containing hydrogen peroxide was measured at 365 mμ against the other solution as the reference blank. (J.G.B.)

22590 A CHEMICAL METHOD FOR THE DETERMINATION OF TRACES OF CHLORINE IN ORGANIC COOLANTS FOR NUCLEAR REACTORS. Serrini, G.; Leyendecker, W. (EURATOM–CCR, Ispra, Italy). Anal. Chim. Acta; 50: 59-69(Apr 1970). (In French).

A method for the determination of traces of chlorine in organic coolants is described. The proposed method is based on the combustion of the organic matter in a quartz burner with a flow of oxygen, and final determination of chloride by a null-point potentiometric titration. With a 20-g sample a detection limit of 0.1 ppM is achieved. At the 0.14 ppM level the coefficient of variation is about 12%. The method requires 30 min for one determination. (auth)

22591 A NEW COULOMETRIC TITRATION METHOD. APPLICATION TO THE DETERMINATION OF URANIUM. Lingane, James J. (Harvard Univ., Cambridge, Mass.). Anal. Chim. Acta; 50: 1-14(Apr 1970).

A new coulometric titration technique was developed, which is applicable to substances that undergo reduction or oxidation in at least two stages at potentials that are several tenths of a volt apart. Electrolysis is performed with the potential of the working electrode controlled by a potentiostat at a value sufficient to cause both stages of the reduction or oxidation to occur, so that the product of the second stage is produced and reacts in the solution with the initial substance to yield the product of the first stage. Instead of carrying the controlled potential electrolysis to exhaustion, the titration is stopped at a discrete end-point (signalled potentiometrically, amperometrically, or by other means) corresponding to the completion of only the first stage, and the quantity of substance reacted is evaluated from the number of coulombs required to reach this end-point. As an example, the titration of +6 uranium to the +4 state, via the +3 uranium produced during reduction of the solution at a mercury cathode, was studied. In either 0.2 M hydrochloric acid or in 0.03 M hydrochloric acid plus 0.5 M potassium chloride as supporting electrolytes, 15 to 60 mg quantities of uranium are determinable with an error of +0.4%. Because this error, caused by catalyzed reduction of hydrogen ion, is reproducible, it can be corrected for, to yield results correct to ±0.1%. (auth)

Isotopic Procedures

22592 APPRAISAL OF THE DOUBLE ISOTOPE DILUTION TECHNIQUES FOR THE MEASUREMENT OF PLASMA ALDOSTERONE. Bayard, Francis (Johns Hopkins Univ., Baltimore); Kowarski, Avinoam; Weldon, Virginia V.; Migeon, Claude J. J. Lab. Clin. Med.; 75: 347-54(Feb 1970).

A modification of double isotope dilution methods for the measurement of plasma aldosterone previously reported (Brodie, A. H., et al., J. Clin. Endocr. 27: 997(1967) and Methods in Hormone Research, 2nd ed., New York, 1968, Vol. 1, Academic Press, Inc., p. 323 and Coghlan, J. P., et al., J. Clin. Endocr. 27: 1470 (1967) and Hormones in Blood, 2nd ed., New York, 1967, Vol. 2, Academic Press, Inc., p. 391) is described in which the proper steps were retained, but the troublesome ones were avoided. The modified method is essentially a composite of the two previously described methods. The results obtained were similar in all cases. (P.C.H.)

Radiometric Procedures

Refer also to abstracts 22799 and 23011.

22593 (CEA-R-3908) DETERMINATION OF ^{90}Sr IN RADIOACTIVE EFFLUENTS BY MEANS OF THENOYLTRIFLUOROACETONE. Testemale, Gilbert; Leredde, Jean-Louis (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1970. 26p. (In French). Dep. CFSTI (U. S. Sales Only).

A method for the determination of ^{90}Sr in radioactive wastes was developed. The separation of ^{90}Sr was carried out by solvent extraction using thenoyltrifluoroacetone and tributyl phosphate in carbon tetrachloride. In order to remove rare earth and yttrium impurities, the purification of ^{90}Sr was effected by another solvent extraction using thenoyltrifluoroacetone in benzene. The ^{90}Sr sources were measured by β^- counting. The yield was about 97 per cent. (France)

22594 RADIOCHEMICAL ANALYSIS ON ION EXCHANGE FILTERS: DETERMINATION OF URANIUM ISOTOPES IN URINE. Clanet, F.; Ballada, J. (CEA, Fontenay-aux-Roses, France). Int. J. Appl. Radiat. Isotop.; 21: 147-54(Mar 1970). (In French).

A new method for the determination and separation of uranium isotopes in urine based on filtrations on paper impregnated with ion exchange resins is described. The optimum operating conditions were determined and two techniques are given. The method is especially suitable for routine monitoring of occupational contamination by uranium. It has also a general application in radiochemical analysis. (auth) (UK)

22595 ALPHA AND FISSION COUNTING OF THIN FOILS OF FISSILE MATERIAL. White, P. H. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods; 79: 1-12(1970).

In 2π alpha and fission counting of active foils corrections are necessary for particles which do not enter the counting volume but dissipate their energy in the thickness of the foil. Measurements of these corrections have been made for foils of uranium oxide prepared by a painting technique, by vacuum evaporation and by electro-spraying. A comparison of the measurements with calculated values of the corrections gives discrepancies of up to 5%/mg cm^{-2}. For both alpha and fission counting this discrepancy can be explained by assuming that the foils have a non-uniformity of the same order as their thickness. The relationship of this "non-uniformity" to the method of preparation is discussed. The backscattering correction applied to alpha particle counting has been recalculated and shown to be a function of the foil thickness. Corrections for low geometry counting are also discussed. Typical fission fragment and alpha particle spectra are shown for both 2π and low geometry assay. (auth)

22596 ANALYSIS OF FISSILE NUCLIDE MIXTURES BY DELAYED NEUTRON EMISSION. Cavallari, F.; Terrani, M.; Terrani, S. (Politecnico, Milan). Nucl. Instrum. Methods; 79: 69-76(1970).

The delayed neutron emission following fission can be used for the analysis of mixtures of fissile nuclides with various techniques. The one based on irradiation in different neutron spectra from a thermal reactor is described and compared with the dynamical methods. The problems connected with the analysis are presented and discussed with particular attention to the determination of its limits and to the influence of the experimental parameters on them. The application to two mixtures, important in practice, is also presented and discussed. (auth)

22597 RADIOCHEMICAL AND ELECTROCHEMICAL METHOD FOR IODIDE ADSORPTION AT THE DROPPING Hg ELECTRODE. Leonhardt, W. (Technische Univ., Dresden). J. Electroanal. Chem. Interfacial Electrochem.; 24: 79-89(1970). (In German).

Specific adsorption of iodide ions at the dropping mercury electrode in solution of x M KI + (0.01 – x) M KF (x = 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}, and 0) was studied by a new radiochemical method as well as by the previously little used capacity current method. The results of both methods and also the values in the literature agree in a certain region. However, by the radiochemical method it is possible to investigate adsorption isotherms at very high dilutions and large positive charges (up to q = +20 $\mu C\ cm^{-2}$) where the electrochemical method cannot be used. The radiochemical method has a charge independent blank value that becomes negligible at high dilutions. (auth)

22598 DETERMINATION OF TRITIUM CONTENT IN WATER AND SEWAGE. Haschke, J. (Hygienische Institutes der Freien und Hansestadt, Hamburg). Arch. Hyg. Bakteriol.; 153: 383-9(1969). (In German).

A simple routine determination of tritium in water and sewage is described. The samples are composed of 3 ml of water or sewage and 15 ml of dioxane radioactive tracer substance. The accuracy obtained amounts to ~3×10^3 pCi/l, a value lower by a factor of 1000 than the maximum permissible concentration in water from a controlled area. The separation of tritium and any other radioactive nuclides can be achieved by means of precipitation or flocculation with the removal of suspended particles and other admixtures by filtration. Any complications involved are discussed. In a series examination of waters and sewage in Hamburg, tritium could be detected and determined in one sample of sewage. (auth)

22599 LIQUID SCINTILLATION COUNTING COMPOSITIONS. (to Monsanto Co.). British Patent 1,179,967. 4 Feb 1970. Priority date 4 Jan 1967, United States.

A composition suitable for liquid scintillation counting of aqueous samples is described. The composition comprises xylene, a scintillation solute, and an ethylated nonyl phenol having an average of from 8.8 to 9.6 ethoxy groups per molecule or an ethoxylated dodecyl phenol having an average of 9.0 to 10.5 ethoxy groups per molecule. (W.H.K.)

22600 RADIOCHEMICAL DETERMINATION OF NUCLEAR FUEL BURN-UP IN IRRADIATED URANIUM DIOXIDE. Bulovic, V.; Krtil, J.; Maksimovic, Z. Bull. Boris Kidric Inst. Nucl. Sci., Chem.; 20: No. 1, 1-7(Feb 1969).

The burnup of several specimens of natural UO_2, irradiated 20 to 30 days in a reactor and cooled for 60 and 300 days, was determined by weighing deposited ^{137}Cs and ^{144}Ce. From a mixture of fission products cesium was separated by extraction with dipicrylaminate of lithium in nitrobenzene and cerium was separated by extraction with bis(2-ethylhexyl) phosphate. The separated amounts of ^{137}Cs and ^{144}Ce were determined on a scintillation gamma spectrometer by comparing with a standard. The burnups of both fission products do not differ more than 5% which is within the error of measurement. (auth)

22601 NONDESTRUCTIVE ASSAY OF PLUTONIUM REACTOR FUEL BY GAMMA RAY MEASUREMENTS USING ON-LINE COMPUTER CONTROL. Brandenburg, R. W.; Beyer, N. S.; Perry, R. B. (Argonne National Lab., Ill.). Mater. Eval.; 28: 77-80; 87(Apr 1970).

The nondestructive assay of the plutonium content of nuclear reactor fuel was accomplished by measurements of the gamma radiation emitted by the plutonium. The fuel was in the form of a ternary alloy (69.3 wt % depleted uranium, 28.2 wt % plutonium, and 2.5 wt % molybdenum). An inventory of approximately 3,000 kilograms of plutonium consisting of more than 12,000 fuel elements will be required for the reactor and a large proportion of these elements was assayed by this technique. Measurement of gamma rays having an energy of approximately 420 keV which are characteristic of plutonium-239 was quantitatively made using a germanium/lithium drifted detector and correlated with flux measurements from standards. An on-line computer formed the heart of the apparatus which affected the measurements. It controlled the basic components of the apparatus such as the detector, X-Y positioning table fuel element conveyor, analog to digital converter and processed the data collected for immediate printed readout of assay values. (auth)

22602 RADIOMETRIC DETERMINATION OF PERCHLORATE BY SOLVENT EXTRACTION AS ION ASSOCIATION COMPLEX. Shigematsu, Tsunenobu; Matsui, Masakazu; Aoki, Toru; Ito, Masahiko (Kyoto Univ.). Jap. Anal.; 19: 412-14(Mar 1970). (In Japanese).

A trace amount of perchlorate was extracted as an ion associa-

tion complex with Zn-phenanthroline (labeled with ^{65}Zn) into nitrobenezene. The activity of ^{65}Zn in the organic phase corresponded to the amount of perchlorate. The method was more sensitive than the absorptiometric method. (auth)

22603 ON THE FISSION TRACK METHOD FOR THE DETERMINATION OF THE URANIUM CONTENT OF WHOLE ROCK SAMPLES. Murali, A. V.; Parekh, P. P.; Das, M. Sankar (Bhabha Atomic Research Centre, Trombay, India). Anal. Chim. Acta; 50: 71-7(Apr 1970).

The induced fission track technique in conjunction with internal standard addition was used for determination of uranium in geological samples. Convenient aliquots of the sample solution spiked with known amounts of uranium, deposited and dried on "Lexan," were irradiated in CIRUS (thermal flux $2 \cdot 10^{12}$ n cm^{-2} sec^{-1}; irradiation time 40 min). These irradiated "Lexan" pieces were etched with 25% (w/v) sodium hydroxide for 2 min at 200°C to reveal the tracks. From a count of track densities in the "Lexan," the uranium contents of the two USGS rock standards G-2 and BCR-I were determined to be 2.01 and 1.64 ppM or uranium, respectively; these results are in good agreement with the literature values. (auth)

Activation Procedures

Refer also to abstract 23051.

22604 (COO-912-20) NEUTRON ACTIVATION ANALYSIS OF ARCHAEOLOGICAL ARTIFACTS. Gordus, Adon A. (Michigan Univ., Ann Arbor). 26 Feb 1970. 22p. (CONF-691207-1). Dep. CFSTI.

From Symposium on the Impact of Natural Sciences on Archaeology, London, England.

The elemental compositions of archaeological artefacts, ancient and medieval coins, and metallic art objects were determined by nondestructive neutron activation analysis. Examples are given of studies of prehistoric trade routes and cultural contacts based on the identification of the geologic origins of obsidian artefacts, of early economic systems based on the determination of debasement patterns in medieval Islamic and Western gold and silver coinage, the region of manufacture as well as authentication of ancient metallic art objects based on trace element analysis. Special procedures devised for performing these analyses are described. (auth)

22605 (PAECL/CHEM-117) ACTIVATION ANALYSIS OF COPPER, MANGANESE, ZINC, NICKEL, AND SODIUM IN CITRUS AND TOMATO LEAVES. Qureshi, Iqbal H.; Cheema, M. Nawaz (Atomic Energy Centre, Lahore (Pakistan). Chemistry Div.). Feb 1970. 22p. Dep. CFSTI (U. S. Sales Only).

Neutron activation analysis was used, in conjunction with chemical separation procedures, for the simultaneous determination of copper, manganese, zinc, nickel, and sodium in citrus leaves and tomato leaves. The heterocyclic dye PAN was used as a chelating agent for the simultaneous extraction of copper, manganese, zinc, and nickel. Various factors affecting the formation and extraction of PAN-metal chelates of these elements were studied and optimized. These elements were selectively stripped from the organic phase into suitable aqueous solutions. The effects of matrix elements on the extraction were also investigated. The accuracy and reproducibility of the procedure were tested by applying it to a standard plant material, Bowen's Kale. The procedure developed is simple and selective and requires about two hours for the chemical processing of duplicate samples. It can be applied to almost all biological materials for the analysis of these elements. (auth)

22606 (UJV-2319-Ch) NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF MINERAL MATERIALS. I. Vobecky, M.; Randa, Z.; Benada, J.; Kuncir, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jan 1970. 113p. Dep. CFSTI (U. S. Sales Only).

An attempt was made to survey systematically nondestructive methods using in-reactor neutron activation and semiconductor gamma spectrometry for analyses of mineral materials. Gamma spectra, measured by means of a spectrometer with a lithium-drifted germanium detector one or more hours after activation of the sample by neutrons, are summarized for 27 minerals and rock samples. Spectra are given for 43 elements whose radionuclides are most frequently identified in the gamma spectra of those mineral materials. (auth)

22607 AUTOMATION IN NEUTRON ACTIVATION ANALYSIS AND ITS APPLICATIONS TO INDUSTRIAL PRODUCTION. Perdijon, J. (Centre d'Etudes Nucleaires, Grenoble, France). Talanta; 17: 197-201(1970). (In French).

Reasons are given for the applications of activation analysis being generally confined to laboratory use. Conditions are given for application of analytical methods to industrial process control, in particular for automatic determination of oxygen in steels. (auth) (UK)

22608 APPLICATION OF ACTIVATION ANALYSIS TO THE EVALUATION OF TEXTILE STAIN REMOVAL PROPERTY. Kobayashi, Massaharu. Sen'i; 21: 606-9(Oct 1969). (In Japanese).

The stain removal property (SR) refers to easy removal of stains on textile fibers by washing and the prevention of restaining during washing. Experiments were carried out on the tracing of oily stain and its behavior by activation analysis. First, the reaction of some metal, readily activated by irradiation, with oily stain was utilized: the metal was copper, and the oily stain was stearic acid. The nuclear reaction for activation analysis was (n, γ). The textile fibers were polyester and cotton. Then, manganese stearate was also tested. The fiber textile was polyester. In both cases, the results of oily-stain tracing were not good, with poor correspondency between, before, and after the washing. (NSA of Japan)

22609 RAPID NEUTRON ACTIVATION METHOD FOR DETERMINATION OF IODINE IN MILK. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). J. Dairy Sci.; 53: 420-2(Apr 1970).

A simple method for determination of total iodine in milk, based on neutron activation analysis is described. After the irradiation, iodine is separated from the milk samples by a radiochemical procedure based on solvent extraction and precipitation, and ^{128}I activity is subsequently measured with a gamma spectrometer. Precision of the method at iodine concentrations of the order of 0.1 ppM is about 5%. (auth)

22610 ANALYSIS OF SURFACE AND BULK IMPURITIES IN SILICON SINGLE CRYSTAL SLICES BY NEUTRON ACTIVATION. Lunde, Gulbrand (Central Inst. for Industrial Research, Oslo). Solid State Technol.; 13: 61-4(Jan 1970).

A method for separating and analyzing bulk and surface impurities in silicon single crystal slices was developed. The method is based on etching the neutron-activated silicon with an etching agent in which inactive elements of the elements to be analyzed are dissolved. Analyses of the following impurities, zirconium, gold, copper, sodium, and arsenic, performed on silicon material delivered from different producers are presented. The results indicate that most of the impurities are located on the surface of the silicon. (auth)

22611 CADMIUM DETERMINATION IN THE LIVER AND KIDNEYS OF CHILDREN AND JUVENILES BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Henke, G.; Sachs, H. W.; Bohn, G. (Univ., Muenster, Ger.). Arch. Toxikol.; 26: No. 1, 8-16(1970). (In German).

Cadmium concentrations of 4×10^{-3} to 8.8 and $< 2 \times 10^{-3}$ to 1.2 $\mu g/g$ fresh weight tissue were found in kidney and liver, respectively, for 41 children and juveniles by means of neutron activation analysis. Cadmium was detectable even in newborns. The Cd concentrations increased 200-fold during the first 3 yr of life. (auth)

22612 NON-DESTRUCTIVE DETERMINATION OF THE CEMENT CONTENT IN CONCRETE. Frevert, E.; Muehlberger, F. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Isotopenpraxis; 6: 18-20(Jan 1970). (In German).

A method for determining the cement content in concrete in a simple nondestructive manner is described. A very exactly known amount of a definite element is added to the cement in perfectly homogeneous distribution. After making the concrete, this element may be activated by neutron irradiation. Radiation intensity is the measure of cement concrete. Indium is proposed as the tracer element. The duration of one measurement is about 55 s. The extra expenses for concrete making by using this technique are given. (auth)

22613 NEUTRON ACTIVATION ANALYSIS METHOD SUITABLE TO LARGE SCREENING OF CYSTIC FIBROSIS. Caramello Gandolfo, M. T.; Strigazzi, A. (Polythecnic, Turin). Panminerva Med.; 11: 582-6(Dec 1969).

Studies were made on the use of neutron activation analysis to measure Na concentration in children's nails to detect early CF subjects, who show usually a considerable increase in nail Na content. This method, which was a preliminary study on 60 non CF children, requires very small quantities of nails, is simple, precise, and rather cheap in comparison with other methods: it seems, therefore, particularly suitable in large CF screening of children. (auth)

22614 DETERMINATION OF THE IRRADIATION TIME IN ACTIVATION ANALYSIS. EXAMPLE OF A RADIOISOTOPE IN

THE PRESENCE OF ANOTHER ONE WITH A LONGER HALF-LIFE. Fedoroff, Michel (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 270: 692-5(23 Feb 1970). (In French).

In activation analysis, it is often desirable to effect the determination of an element with shorter half-life in the presence of another one with longer half-life, the two being produced simultaneously. An equation is proposed for the calculation of the irradiation time giving the best detection sensitivity. The application of this equation for the determination of Al in the presence of Mn is verified. (France)

22615 SURFACE PROFILE ANALYSIS BY ^{3}He ACTIVATION; OXYGEN IN SILICON. Lamb, James F.; Lee, Diana M.; Markowitz, Samuel S. (Univ. of California, Berkeley). Anal. Chem.; 42: 22-15(Feb 1970).

^{3}He activation analysis was used for oxygen surface profile analysis of high-purity silicon. Theoretical maximum recoil ranges of ^{18}F produced by ^{3}He activation of ^{16}O were calculated for the target matrices C, Al, Ti, Cu, Ag, Te, Gd, Ta, and Au based upon total momentum transfer. The incident ^{3}He ion energies were 1 to 35 MeV. The predicted maximum recoil ranges in aluminum were verified experimentally at 5, 10, 20, and 25 MeV using thin Al catcher foils. The experimentally measured distribution of induced ^{18}F activity in high-purity silicon obtained using 8-MeV ^{3}He ions was then compared with prediction based upon the theoretical curves and with results in the literature from similar experiments using ^{4}He activation. An oxygen concentration of about 1 ppM in bulk silicon was found, and the maximum recoil range was determined to be about 0.5 mg/cm^2. (auth)

22616 DETERMINATION OF IMPURITIES IN TITANIUM AND TITANIUM DIOXIDE BY NEUTRON ACTIVATION ANALYSIS. PART V. DESTRUCTIVE AND NON-DESTRUCTIVE DETERMINATION OF MANGANESE, INDIUM, AND URANIUM. Neirinckx, R.; Adams, F.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta; 50: 31-8(Apr 1970).

Manganese, indium, and uranium in titanium, titania powder and titania crystals can be determined nondestructively or destructively, by means of solvent extraction with tri-n-butyl phosphate. Destructively, the sensitivity for the determinations is enhanced by a factor of 20. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 22688, 22697, 22765, 22766, 23040, 23427, 23452, 23771, 23816, 24201, and 24920.

22617 (AEC-tr-6983/1 and 2) HANDBOOK OF SOLID-LIQUID EQUILIBRIA IN SYSTEMS OF ANHYDROUS INORGANIC SALTS. VOLUME I. BINARY SYSTEMS. VOLUME 2. TERNARY SYSTEMS, RECIPROCAL TERNARY SYSTEMS, AND MULTICOMPONENT SYSTEMS. Voskresenkaya, N. K. (ed.). Translation of Spravochnik po Plavkosti Sistem iz Bezvodnykh Neorganicheskikh Solei, Izdatel'stvo Akademii Nauk SSSR, Moscow-Leningrad, 1961. 1453p. (TT-69-55079/1; IPST-Cat.-5519; TT-69-55079/2; IPST-Cat.-5520). Dep. CFSTI $3.00 Ea. Pt.

These reports are issued separately, but cataloged as a unit.

The selection of the compounds included in the handbook was somewhat arbitrary, since the concept of a salt has not been precisely defined. In addition to the compounds conventionally known as salts, stannic bromide and iodide, antimony halides, and alkali hydroxides, which are solid at room temperature are also included. Sulfide and silicate systems were not included. In addition to fusibility data, such as temperatures of incipient and completed crystallization, data concerning the subsolidus transformations of the systems are also included. The literature covers the period 1884 to 1955. The systems are arranged in alphabetical order by symbols of elements. If more than one publication was available on a given system, the publications were arranged in chronological order. All diagrams have been reproduced from the original sources. Separate author, salt, and system indexes are included. (P.C.H.)

22618 (CEA-CONF-1418) POLYMER-SUBSTRATE BINDING IN RESINIFIED WOOD OBTAINED BY A RADIOCHEMICAL METHOD. Guillemain, J. (Centre Technique du Bois, Paris (France)); Laizier, J.; Marchand, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Roland, J. C. (Paris Univ. (France). Laboratoire de Biologie Vegetale). [1967]. 28p. (In French). (CONF-690805-11). Dep. CFSTI (U. S. Sales Only).

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

The utilization of monomer–solvent–water homogeneous ternary mixtures confers to treated beech wood an excellent dimensional stability. These results contrast with those obtained when using a pure monomer or even in using a monomer in an aqueous emulsion or in a mixture with a solvent such as dioxane. In these latter cases the stabilization in effect is very slight or zero. In the case of the ternary mixtures the polymer retained by the wood is not completely extractable. The quantity of polymer fixed increases with the amount up to a plateau whose height varies with the type of solvent. Electron microscopic examination of the woods thus treated reveals a very great modification of the walls of the cells. The cellulose layers appear to have been exposed to a filling up and are in a distended state that can be attributed to grafting. Diverse methods of degradation of the resinified woods, applied with the purpose of separating the copolymer and of characterizing it, were used: hydrolysis of the polyosides in order to isolate the lignin, delignification with sodium chlorite in order to obtain the holocellulose, determination of the pentosans, and determination of the methoxyl groups. At each step the polymer recovered was analyzed by infrared spectroscopy. Grafting on the cellulose fraction of the material was revealed. The increase of the mean molecular mass and the decrease of solubility of the cellulose lead to the supposition of a supplementary reticulation reaction. The weight balances that differ according to the order in which the extractions were made show a retention effect exercised by the lignin with respect to the polymer, a retention that can be interpreted as a grafting. The resinified woods thus characterized appear as compositions very different from the irradiated impregnated woods. Their dimensional stability is conferred by a chemical fixation of the polymer to the ligno-cellulose material. This fixation is certain on the cellulose and is accompanied by a reticulation in the cellulose. It is not improbable in the case of lignin. This chemical modification is accompanied by a significant change in the anatomy of the cell wall. (tr-auth)

22619 (CEA-R-3963) REACTIONS $UF_4 + ClO_2F$ AND $UF_5 + ClO_2F$. Benoit, Raymond; Besnard, Ginette; Hartmannshenn, Olivier; Luce, Michel; Mougin, Jacques; Pelissie, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 39p. (In French). Dep. CFSTI (U. S. Sales Only).

The study of the reaction $UF_4 - ClO_2F$ between 0 and 100°C, by various techniques (microsublimation, isopiestic method, ir and uv spectrography, thermogravimetry, and x-ray diffraction) shows that intermediate steps are possible before the production of UF_5. The whole reaction can be schematized by the two equations: (1) $n\ UF_4 + ClO_2F \rightarrow n\ UF_x + ClO_2$ $(4 < x \leq 5)$; (2) $n\ UF_4 + ClO_2F \rightarrow n\ UF_x + \frac{1}{2}\ Cl_2 + O_2$. The second equation becomes experimentally verified when the temperature increases. The reaction at 0°C between UF_5 and ClO_2F can be represented by: $UF_5 + ClO_2F \rightarrow UF_5ClO_2$. The reactions: $UF_5 + ClO_2F \rightarrow UF_6 + ClO_2$ and $UF_5 + ClO_2F \rightarrow UF_6 + \frac{1}{2}\ Cl_2 + O_2$ are verified at 25°C. The second one is preponderant from 50 to 150°C. (France)

22620 (NSRDS-NBS-15) MOLTEN SALTS: VOLUME I. ELECTRICAL CONDUCTANCE, DENSITY, AND VISCOSITY DATA. Janz, G. J.; Dampier, F. W.; Lakshminarayanan, G. R.; Lorenz, P. K.; Tomkins, R. P. T. (Rensselaer Polytechnic Inst., Troy, N. Y.). Oct 1968. 141p. GPO $3.00.

Data on the electric conductivity, density, and viscosity of single-salt melts were compiled from a comprehensive search of the literature up to December 1966 and a critical assessment made of the compiled data. Recommended values were determined and are presented as functions of temperature in the form of equations and tables. The results for some 174 compounds as single-salt melts are reported: no attempt was made to embrace the results for molten salt mixtures. Data are presented for fluorides, chlorides, bromides, iodides, carbonates, nitrites, nitrates, oxides, sulfides, sulfates, and a miscellaneous group. (256 references) (auth)

22621 (NSRDS-NBS-28) MOLTEN SALTS. VOLUME 2. SECTION 1. ELECTROCHEMISTRY OF MOLTEN SALTS: GIBBS FREE ENERGIES AND EXCESS FREE ENERGIES FROM EQUILIBRIUM-TYPE CELLS. SECTION 2. SURFACE TENSION DATA. Janz, G. J.; Dijkhuis, Chr. G. M.; Lakshminarayanan, G. R.; Tomkins, R. P. T.; Wong, J. (Rensselaer Polytechnic Inst., Troy, N. Y.). Aug 1969. 114p. GPO $2.75.

Two sections are included: the first contains a critical evaluation of excess free energies of binary molten salt mixtures with a common ion from equilibrium-type electrochemical cells. For this purpose calculations using the original emf data were systematically undertaken to establish comparisons of free energy values of various workers that would be significant. The reversibility of electrodes was investigated by comparing the electro-

motive force of cells with a single molten salt as liquid electrolyte with thermochemical data. In the second section, data on the surface tensions of single salt melts were systematically collected and evaluated. Results are given for 106 inorganic compounds over a range of temperatures where available. (179 references) (auth)

22622 (ORNL-4366, pp 22-40) SOL-GEL DEVELOPMENT STUDIES. (Oak Ridge National Lab., Tenn.).

The preparation of UO_2 sols by solvent extraction was successfully scaled up, and engineering equipment was operated continuously to produce 6 liters of 0.2 M sol per hour. A 14-liter batch slurry reductor was developed, and was used to produce more than 40 kg of U(IV) nitrate solution that was suitable as feed for the solvent-extraction process. In the extraction process, a 30-min interstage digestion step carried out at about 60°C produced the best-quality sol. The development of processes and equipment for sol-gel ceramic fuels was continued. The two-fluid nozzle in conjunction with turbulent flow conditions was applied to the preparation of sol droplets 20 to 300 μ in diameter, and a dimensionless correlation was derived for the results. (auth)

22623 (ORNL-TM-2763) ADSORPTION AND DESORPTION OF IODINE ON MILD STEEL. Neill, F. H. (Oak Ridge National Lab., Ill.). Apr 1970. Contract W-7405-eng-26. 55p. Dep. CFSTI.

The deposition of iodine on mild steel surfaces was investigated for a range of surface temperatures from 316 to 538°C and for two iodine gas-phase source concentrations, 4.9×10^{-10} and 4.0×10^{-6} atm. Adsorption rates and desorption rates for the sorbed species as a function of surface temperature were determined. The desorbing species was predominantly iron(II) iodide. The experimental data were used to prepare charts showing net adsorption rates and coefficients of desorption. (auth)

22624 (RFP-Trans-65) STUDY OF THE DECARBOXYLATION OF THORIUM TETRAFORMATE. Mentzen, Bernard. Translated for Rocky Flats Div., Dow Chemical Co., Golden, Colo., from Ann. Chim. (Paris); 3: 367-84(1968). 40p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 17416.

22625 (UCRL-19149) SURVEY OF THE LITERATURE ON THE CARBON-HYDROGEN SYSTEM. Krakowski, R. A.; Olander, D. R. (California Univ., Berkeley. Lawrence Radiation Lab.). Mar 1970. Contract W-7405-eng-48. 70p. Dep. CFSTI.

The literature on the carbon-hydrogen system up to ca 1968 is reviewed. The thermodynamics and heterogeneous kinetics of the reaction, the adsorption of hydrogen on graphite, and the evaporation of graphite are considered. (108 references) (auth)

22626 USE OF MODERATELY DISSOCIATED COMPLEXES IN SPECTROPHOTOMETRIC DETERMINATIONS. II. REACTIONS OF ARSENAZO III WITH URANYL AND THORIUM (IV) IONS. Borak, J.; Slovak, Z.; Fischer, J. (Institut fuer Reine Chemikalien, Brno). Talanta; 17: 215-29(Mar 1970). (In German).

The reactions of uranyl ion with Arsenazo III in acid solution gave rise to the formation of two complexes of the type ML, the proportions of these two being dependent on the acidity. The molar absorptivities of the complexes at 565 nm were 5.3×10^3 and 8.8×10^3 l mole^{-1} mm^{-1}. The formation constants have been determined, and the apparent variation in the sensitivity of the reaction is explained. In acid solution thorium formed complexes with Arsenazo III of the types M_2L, ML (two), and ML_2, the last of which is analytically useful, although partially dissociated. It predominates in strongly acid solution containing a large excess of reagent, and has a molar absorptivity at 658 nm of 12.8×10^3 l mole^{-1} mm^{-1}. (auth) (UK)

22627 VAPOR PRESSURE ISOTOPE EFFECTS OF THE DEUTERATED ACETYLENES. Phillips, James T.; Van Hook, W. Alexander (Univ. of Tennessee, Knoxville). J. Chem. Phys.; 52: 495-502(15 Jan 1970).

The vapor pressures of the isotopic acetylenes: C_2H_2, C_2HD, and C_2D_2, have been investigated by mercury manometry. Samples of relatively pure C_2HD were prepared for this purpose by low-temperature gas chromatography. The vapor pressure measurements were made from 0.5 to 800 mm pressure (125 to 190°K) with a precision of ~0.01 mm. The vapor pressure isotope effects were normal with the isotope effect for C_2HD being slightly larger than the rule of the mean value. The data for C_2D_2 showed a sharp change in the temperature dependence at 147.4°K which has been interpreted as a result of a solid-solid phase transition in C_2D_2. The experimental results have been considered in the light of the statistical theory of isotope effects in condensed systems. A model calculation made within the framework of this theory is in agreement with the experimental data. (auth)

22628 METASTABLE IONS AND ISOTOPE EFFECTS IN THE MASS SPECTRA OF PROPANE AND DEUTERATED PROPANES. Vestal, Marvin (Scientific Research Instruments Corp., Baltimore); Futrell, Jean H. Contract AF33(657)-10846. J. Chem. Phys.; 52: 978-88(15 Jan 1970).

Metastable transitions occurring in the mass spectrum of C_3H_8, $CH_3CD_2CH_3$, $CD_3CH_2CD_3$, and C_3D_8 have been investigated by means of the defocusing technique using a double-focusing mass spectrometer. In addition, detailed calculations of the decomposition of propane ions have been carried out, using the quasiequilibrium theory of mass spectra. Very strong isotope effects were observed and were accounted for quantitatively, and it was concluded that the quasiequilibrium theory provides an adequate framework for the description of both metastable ions and the general fragmentation processes responsible for the mass spectra of the deuterated propanes. (auth)

22629 PROPERTIES AND APPLICATIONS OF URANIUM GLASSES. Wilk, H. F. (Zaklad Badan i Doswiadczen Przemyslu Szklarskiego, Krakow). Szklo Ceram.; 20: 166-8(1969). (In Polish).

A comprehensive survey was made of the literature concerning uranium glasses. It was found that investigations have covered quite a wide range comprising glasses both of high uranium content (for nuclear engineering) and of low uranium content (colored general purpose glasses), while publications on uranium glasses intended for laser techniques are largely limited with respect to their synthesis. (auth)(NSA of Poland)

22630 STUDIES ON THE PMR SPECTRA OF OXETANES. I. 2-PHENYLOXETANE. Jokisaari, Jukka; Rahkamaa, Erkki; Virtanen, P. Olavi I. (Univ. of Oulu, Finland). Suomen Kem.; 43B: 14-17(1970).

The 60-MHz magnetic resonance spectrum of the oxetane protons in 2-phenyloxetane has been analyzed as an ABCDE spectrum. The chemical shifts and proton-proton couplings are reported. (auth)(Finland)

22631 GROUND STATE VIBRATIONAL LEVELS OF ZINC URANYL ACETATE. Garg, C. L.; Narasimham, K. V. (Defence Science Lab., Delhi). Spectrochim. Acta, Part A; 26: 627-35(Mar 1970).

The vibrational levels in the ground state of zinc uranyl acetate $[Zn(UO_2)_2(CH_3COO)_6 \cdot 7H_2O]$ were established from investigations of Raman, infrared, and fluorescence spectra of the compound, and the fluorescence spectrum was analysed on the basis of these vibrational frequencies. The Raman spectrum was obtained with a helium-neon laser as the excitation source, the infrared absorption spectrum was recorded by both Nujol mull and potassium bromide disc techniques, and the fluorescence spectrum was photographed with powder samples of the compound at liquid air temperature. Besides the uranyl frequencies, eleven fundamentals due to the acetate ion and three fundamentals due to the crystal lattice were observed in the infrared and fluorescence spectra. Good agreement was obtained between the values of the various fundamental frequencies from the different investigations. The interpretation given for a fluorescence spectrum confirms the analysis proposed by Dieke and Duncan involving a single electronic transition from the lowest excited state of the uranyl ion to the various vibrational levels of the ground state. (auth) (UK)

22632 REACTIONS OF 8-QUINOLINOL WITH COVALENT HALIDES. PART IV. PENTACHLORIDES AND PENTABROMIDES OF NIOBIUM AND TANTALUM. Frazer, M. J.; Gillespie, B. G.; Goldstein, M.; Haines, L. I. B. (Northern Polytechnic, London). J. Chem. Soc., A; No. 5, 703-7(1970).

The reactions, in sealed tubes, of 8-quinolinol (oxH) with niobium or tantalum pentachlorides or pentabromides (MX_5) produced materials of composition MX_5,n(oxH) (n = 2, 4, 5, 6, 8, or 10). These materials were mixtures, which, on heating, yielded compounds of the type $MX_m(ox)_{5-m}$ (m = 1-3). Compounds $MX_4(ox)$ have also been prepared, affording all combinations of M, X, and m [except for $NbBr_2(ox)_3$]. $NbBr(ox)_4$ and $TaBr(ox)_4$ are 1:1 electrolytes, but conductance measurements and ir spectroscopy (4000-80 cm^{-1}) indicated that the other compounds are nonelectrolytes with metal coordination numbers of 9, 8, 7, and 6 for m = 1-4. (auth) (UK)

22633 NN-DIETHYLDITHIOCARBAMATE COMPLEXES OF TRIVALENT LANTHANIDE AND ACTINIDE ELEMENTS AND THE CRYSTAL STRUCTURE OF TETRAETHYLAMMONIUM NEPTUNIUM(III) TETRAKIS-(NN-DIETHYLDITHIOCARBAMATE). Brown, D.; Holah, D. G.; Rickard, C. E. F. (Atomic Energy

Research Establishment, Harwell, Eng.). J. Chem. Soc., A; No. 5, 786-90(1970).

Trivalent lanthanide and actinide complexes of the types $M(dtc)_3$ and $NEt_4M(dtc)_4$ (M = Np, Pu, and La to Lu inclusive, except Pm; dtc = NN-diethyldithiocarbamate) were prepared by reactions in nonaqueous solvents. Some chemical properties, ir and visible spectra, and crystallographic properties are reported. Three distinct crystal forms were observed for different neutral complexes, whereas the tetrakisdiethyldithiocarbamates are all isostructural. The structure of $NEt_4Np(dtc)_4$ was determined by single-crystal x-ray diffraction methods. It crystallises in the monoclinic space group $P2_1/c$ (C_{2h}^5) with Z = 4 in a unit cell of dimensions a_0 = 11.68, b_0 = 20.49, c_0 = 19.14 Å and β = 116.5°. The neptunium atoms are each bonded to eight sulphur atoms with a mean Np–S distance of 2.87 Å. (auth) (UK)

22634 CONCENTRATION OF COBALT SOLUTIONS BY REVERSE OSMOSIS. Goff, David Lee. Austin, Tex.; Univ. of Texas (1969). 114p.

Thesis.

A study was carried out to characterize and describe the transport of cobalt solutions through a reverse osmosis (RO) membrane, evaluate the capability of a commercial RO system to concentrate low-level radioactive cobalt solutions, and compare the results of the laboratory RO studies to the performance of a commercial RO system. Both nonradioactive and radioactive solutions were used in this investigation. This investigation showed that solute transport through these membranes occurred by two processes; a "diffusional" process driven by the solute concentration difference across the membrane and a pressure dependent process driven by the pressure difference across the membrane. The larger contribution of the pressure-driven process in most membrane modules was predominant in influencing decontamination performance of the commercial system. Decontamination factors observed for radioactive cobaltous and cobaltic chelate solutions were approximately 20 and 50, respectively. Concentration factors were approximately 2.5 for these same solutions. The overall decontamination and concentration capability of the commercial RO system was limited as a result of the pressure-driven transport of cobalt through the membranes, individual variation between membrane modules, and the manner in which the modules were located in the system, i.e., system design. (Diss. Abstr. Int. B)

22635 ADSORPTION OF CARBON DIOXIDE BY THORIA SOLS. Thomas, I. ?.. (Oak Ridge National Lab., Tenn.). J. Colloid Interface Sci.; 32: 177(Jan 1970).

The effect of water-saturated CO_2 on a nitrate-stabilized thoria hydrosol (0.73M) was studied using a Waters Associates Streaming Current Detector. Under a CO_2 atmosphere, the streaming current decreased for a few minutes, then remained constant. When the CO_2 was flushed away with Ar, the streaming current returned to its original value. Dialysis experiments indicated that nitrate ions were reversibly replaced from the surface of the sol by the CO_2. Similar results were noted for urania and europia sols. (B.L.M.)

22636 ISOTOPE EFFECTS IN HYDROGEN BONDING IN SOLIDS. Delaplane, Robert Gearhart. Evanston, Ill.; Northwestern Univ. (1969). 167p.

Thesis.

Cobaltic acid, $HCoO_2$, and deuterated cobaltic acid, $DCoO_2$, were prepared and studied by x-ray and neutron diffraction techniques, and by infrared spectroscopy and cold-neutron scattering. The materials crystallize in apparent space group D_{3d}^5-$R\bar{3}m$ of the trigonal system with three molecules in a hexagonal cell of dimensions: $HCoO_2$, a = 2.851(1), c = 13.150(5) Å; $DCoO_2$, a = 2.854(1), c = 13.354(5) Å. The O–O distance, as determined by neutron powder studies of $HCoO_2$ is 2.50(2) Å. On this basis and the fact that there are three O–H–O bonds along the c direction, the O–D–O distance is 2.57(2) Å. Hence, the isotope effect here is as large as in the system $HCrO_2$–$DCrO_2$. Infrared studies at room temperature and at –195°C over the region 70 to 4000 cm^{-1} may be interpreted in terms of an effectively symmetric O–H–O bond and an effectively asymmetric O–D–O bond. Although the neutron inelastic scattering measurements are not inconsistent with this interpretation, there is an intense band centered at 264 cm^{-1} in the neutron spectrum for $HCoO_2$ that remains unexplained. A three-dimensional x-ray diffraction study of the α modification of both $(COOH)_2 \cdot 2H_2O$ and $(COOD)_2 \cdot 2D_2O$ was made. Crystals of both substances crystallize with two formula units per unit cell in space group $P2_1/n$ of the monoclinic system. The cell constants for α-$(COOH)_2 \cdot 2H_2O$ are a = 6.119(1), b = 3.607(1), c = 12.057(1)Å, and β = 106° 19(1)′; those for α-$(COOD)_2 \cdot 2D_2O$ are a = 6.150(1), b = 3.612(1), c = 12.102(1)Å, and β = 106° 38(1)′. For each compound, intensity data were collected with Cu Kα radiation out to 110° in 2 θ on a Picker automatic diffractometer. Positional and anisotropic thermal parameters for all atoms were refined on F^2 by full-matrix least-squares techniques. A correction for anisotropic extinction effects was included in the least-squares refinement. The weighted R factors on ^2F are 3.9% (547 observed reflections) for α-$(COOH)_2 \cdot 2H_2O$ and 3.9% (555 observed reflections) for α-$(COOD)_2 \cdot 2D_2O$. The corresponding conventional R factors on ^2F are 2.8% and 2.8% respectively; on F are 2.0% and 2.3%. The oxalic acid molecules and water molecules are linked together by a three-dimensional network of hydrogen bonds. All three crystallographically independent O–H–O bonds lengths expand significantly with deuteration while the bond lengths within the oxalate fragment remain unchanged. In α-$(COOH)_2 \cdot 2H_2O$, the O–H–O distances are 2.512(1), 2.864(2), and 2.883(1) Å; the corresponding O–D–O distances in α-$(COOD)_2 \cdot 2D_2O$ are 2.53?(1), 2.880(2), and 2.907(1) Å. There is no direct correlation of these bond-length changes with the lattice-constant changes upon deuteration. The isotope effect is spread throughout the entire hydrogen-bonded network and is not limited to only the strongest hydrogen bond. (Diss. Abstr. Int., B)

22637 ADSORPTION OF WATER VAPOR BY THORIUM OXIDE AND THE EFFECTS OF WATER ON THE OXIDE. Gammage, R. B.; Brey, W. S. Jr.; Davis, B. H. (Univ. of Florida, Gainesville). J. Coll. Interface Sci.; 32: 256-69(Feb 1970).

High-area thorium oxide, outgassed at 200°C, is covered by surface hydroxyl groups and strongly bound water molecules. Gravimetric sorption studies show that a monolayer of water can be physically adsorbed onto this hydration layer. This physisorbed water slowly becomes more firmly bound, apparently as water of hydration of the surface hydroxyl. For one type of thorium oxide, the conversion proceeds more rapidly at relative pressures above 0.5, and adsorption-desorption cycling to 1.0 p/p_0 profoundly changes the nature of the surface to permit a discrete second step in the adsorption isotherm. The second step appears to be associated with restructuring processes. Nuclear magnetic resonance (NMR) data for surface water point not only to a sluggish approach to an equilibrium state but also to the development of special structure in the multilayer region. (auth)

22638 KINETIC ISOTOPE EFFECT ON THE REACTION OF D-AMINO-ACID OXIDASE. Yagi, Kunio; Nishikimi, Morimitsu; Ohishi, Nobuko; Takai, Akiko (Nagoya Univ., Japan). FEBS (Fed. Eur. Biochem. Soc.) Lett.; 6: 22-4(Jan 1970).

The deuterium isotope effect on the kinetics of the formation of the purple intermediate formed and complete conversion to the fully reduced enzymes were studied using α-deuterated DL-alanine and DL-leucine. The formation of the purple intermediate and its complete reduction was followed by differences in the spectrophotometric trace at 550nm. With leucine, deuterium substitution reduced the rate of formation of the purple intermediate by ~⅓. However, with alanine, deuterium substitution caused only a slight decrease in the rate of intermediate formation. The first-order rate constants for reduction of the purple intermediate were virtually unchanged by deuterium substitution indicating that the full reduction probably does not involve a rate-limiting transfer of a species of hydrogen of any kind. (B.L.M.)

22639 TERTIARY BUTYL PROTON SHIFTS AND DEUTERIUM ISOTOPE EFFECTS. Wilk, William David. Evanston, Ill.; Northwestern Univ. (1968). 135p.

Thesis.

Proton chemical shifts and ^{13}C–H coupling constants for over 60 tertiary butyl-containing compounds were measured and reported. Approximate relationships, with exceptions in each case, appear to exist between the t-butyl proton shifts and various properties of the substituents. Deviations may be understood in terms of magnetic anisotropy and inductive effects. The increasing downfield shift for the methyl resonance in the series, methyl, ethyl, isopropyl and t-butyl, most likely arises from a greater inductive effect of methyl than of hydrogen. The deuterium isotope effect on the proton resonance of a series of aliphatic hydrocarbons was measured and reported. On deuterium substitution, the proton resonance of the neighboring protons is shifted to higher field indicating a net shielding. This upfield shift was observed over two, three, and four bonds, but not over five bonds. The magnitude of the isotope shift cannot be explained by different inductive effects of D and H, but may be understood in terms of mean bond length differences between C–D and C–H. (Diss. Abstr. Int., B)

22640 MANGANESE, TECHNETIUM, AND HRENIUM. ANNUAL SURVEY CONVERING THE YEAR 1968. Wojcicki, Andrew (Ohio State Univ., Columbus); Alexander, John J. Organometal. Chem. Rev.; 5: 618-55(1969).

A review concerned with Tc and its chemistry, including a short reference to organometallic compounds, is presented. The structures, preparations, and uses of $Mn_2(CO)_{10}$, its substitution derivatives, and manganese carbonyls are also reviewed. Solubili-

ties of $Mn_2(CO)_{10}$ in several organic solvents, in $Ni(CO)_4$, and in $Fe(CO)_5$ at 20°C, as well as densities and viscosities of these solutions are included. The following subjects are discussed for various organic compounds of Mn, Tc, and Re: synthesis, chemical properties and kinetics; electronic spectra and structures; ir studies; structural studies; mass spectra; NMR studies; Moessbauer studies; and nuclear quadrupole resonance studies. (211 references). (P.C.H.)

22641 DEUTERIUM ISOTOPE EFFECTS IN THE PRINCIPAL ELECTRONIC TRANSITION OF NITROBENZENE AND ANILINE AND THEIR p-ALKYL DERIVATIVES. Schubert, W. M.; Murphy, Richard B.; Robins, Janis (Univ. of Washington, Seattle). J. Org. Chem.; 35: 951-5(Apr 1970).

A study has been made of the effect of p-D vs. p-H, p-CD_3 vs. p-CH_3, and p-$CH_2C(CD_3)_3$ and p-$CD_2C(CH_3)_3$ vs. p-$CH_2C(CH_3)_3$ on the principal electronic transition of nitrobenzene and aniline in the gas phase and in heptane solvent. In all but one instance, that of p-neopentylnitrobenzene vs. p-neopentylnitrobenzene-γ-d_3, deuterium substitution shifted the principal band to slightly higher energies. These results are consistent with the polarizability–electronegativity treatment of substituent effects. (auth)

22642 BASE-CATALYZED DEUTERIUM EXCHANGE IN PYRIDINE N-OXIDES. Gallacher, Ann Immaculata; Lalinsky, Barbara A.; Cuper, Christine M. (Immaculata Coll., Pa.). J. Org. Chem.; 35: 1175-6(Apr 1970).

The base-catalyzed H–D exchange in the aromatic ring and the side chain of alkylpyridine N-oxides and, qualitatively, the dependence of the exchange on base strength are reported. Studies on the isomeric picoline N-oxides revealed ring-proton exchange as well as side-chain exchange. For 2-picoline N-oxide, α-proton exchange accompanied methyl-proton exchange in the presence of sodium carbonate and sodium deuteroxide. The relative amount of ring- and side-chain exchange varied with reaction time and base. The 4 isomer, 4-picoline N-oxide presented an interesting contrast insofar as the amount of ring exchange exceeded side-chain proton exchange in the presence of triethylamine and sodium carbonate. Data for base-catalyzed exchange of benzylpyridine N-oxides in heavy water are tabulated. (P.C.H.)

22643 CATALYSIS OF HYDROGEN ISOTOPE EQUILIBRATION BY RHENIUM. Boon, C.; Gasser, R. P. H.; Tovey, H. (Physical Chemistry Lab., Oxford). Surface Sci.; 19: 255-7 (Jan 1970).

Studies were made to determine if the absorption may be dissociative in the second order kinetics observed for the desorption of hydrogen from rhenium, and also to establish whether rhenium is catalytically active in hydrogen isotope equilibration. The results suggested that catalysis is not closely associated with the desorption of a chemisorbed species, because such desorption only occurs above 350°K. A possible interpretation of the results is that exchange occurred between molecules held in a physisorbed precursor state and atoms resulting from dissociative chemisorption. (P.C.H.)

22644 COORDINATE COMPLEX COMPOUNDS OF CERIUM(III) AND URANIUM(III) TRICHLORIDES WITH ACETONITRILE. Mac-Cordick, John; Brun, Claude (Strasbourg Univ.). Compt. Rend., Ser. C; 270: 620-3(16 Feb 1970). (In French).

The reaction of pure acetonitrile with the anhydrous cerium and uranium trichlorides gives rise to the additive compounds $CeCl_3 \cdot 2\,CH_3CN$ and $UCl_3 \cdot CH_3CN$ in several days. A $CeCl_3 \cdot CH_3CN$ 1:1 cerium compound is obtained from the complex compound 1:2 by thermodecomposition at 180°C. The complex compounds thus prepared are characterized by chemical analysis, thermogravimetry, infrared spectrophotometry, and x-ray diffraction diagrams. (France)

22645 EXCHANGE OF BOUND TRITIUM BETWEEN DNA AND WATER AT DIFFERENT TEMPERATURES. Bird, R. E.; Lark, K. G.; Curnutte, B.; Maxfield, J. E. (Kansas State Univ., Manhattan). Nature (London); 225: 1043-5(14 Mar 1970).

Calf thymus DNA was equilibrated with tritiated water and a small amount of ^{14}C–DNA from E. coli was added as marker. An aliquot of the tritiated DNA was then equilibrated at the desired temperature and passed through a sephadex chromatographic column. The emerging ^{14}C–DNA peak contained less than 1 part in 10^6 of the original ^3H activity, which could be subsequently eluted from the column. Samples from this DNA solution were passed through a second column to remove the free tritium. The bound tritium emerging with the ^{14}C–DNA was scintillation counted. Evidence was obtained for a fast and a slow exchange. It was calculated that the activation enthalpy for exchange is 24 ± 4 kcal/mole of activated complex and is almost the same for fast and slow exchange. It was also deduced that there were about four times as many fast exchanging tritiums as slow. It is suggested that the hydrogens that are exchanging are those involved in base pairing with the DNA helix. The activation enthalpy is too high for the separation of a single base pair, and it seems more likely that the activation event involves the simultaneous separation of two or three base pairs, a thermodynamically stable situation that would preserve the stacking energy within the helix. (UK)

22646 THERMODYNAMICS OF THE ACTINIDE ELEMENTS. PART II. HEATS OF SOLUTION IN AQUEOUS HYDROCHLORIC ACID OF $PaCl_4$(c), $PaBr_4$(c), PaI_4(c), AND UCl_4(c). Fuger, J. (Univ. of Liege); Brown, D. J. Chem. Soc., A; No. 5, 763-4(1970).

The following heats of solution in aqueous hydrochloric acid were measured at 25.00° ± 0.05°C: $PaCl_4$(c) in 1M HCl, −55.59 ± 0.06 kcal/mole, and in 6M HCl, −42.29 ± 0.06 kcal/mole; $PaBr_4$(c) in 1M HCl, −65.44 ± 0.13 kcal/mole, and 6M HCl, −51.70 ± 0.24 kcal/mole; PaI_4(c) in 1M HCl, −75.94 ± 0.17 kcal/mole; and UCl_4(c) in 1M HCl, −54.46 ± 0.23 kcal/mole. These results are compared with the data for the tetrahalides of other actinide elements. (auth)

22647 LANTHANIDES AND ACTINIDES ANNUAL SURVEY COVERING THE YEAR 1968. Calderazzo, F. (Univ., Pisa, Italy). Organometal. Chem. Rev.; 5: 545-6(1969).

A review is presented on the preparation and chemical bonding of triindenylsamarium, tetracyclopentadienylneptunium(IV), and dicyclooctatetraenyluranium(IV). The reactions for the preparations are given, and the bonding was studied by ir and NMR spectra. (P.C.H.)

22648 VIBRATIONAL ASSIGNMENTS AND POTENTIAL CONSTANTS FOR CIS- AND TRANS-1-CHLORO-2-FLUOROETHYLENES AND THEIR DEUTERATED MODIFICATIONS. Craig, Norman C.; Lo, Y.-S.; Piper, Lawrence G.; Wheeler, John C. (Oberlin Coll., Ohio). J. Phys. Chem.; 74: 1712-27(16 Apr 1970).

From infrared and Raman spectra a complete assignment of vibrational fundamentals was obtained for cis- and trans-CClHCFH, CClDCFH, CClHCFD, and CClDCFD. For cis-CClHCFH the a′ modes are 3114, 3102, 1661, 1335, 1231, 1062, 812, 656, and 205 cm^{-1}, and the a″ modes are 857, 735, and 442 cm^{-1}. For trans-CClHCFH the a′ modes are 3103, 3094, 1647, 1296, 1218, 1127, 876, 447, and 270 cm^{-1}, and the a″ modes are 888, 784, and 270 cm^{-1}. ΔE_0° (electronic) is then found to be 867 ± 90 cal/mol with the cis isomer having the lower energy. Urey–Bradley force constants for the in-plane vibrations were calculated by fitting the frequencies of all eight species at once. General valence force (GVF) constants for the out-of-plane modes were calculated for the cis and trans species separately. The GVF constants for the two isomers are consistent with each other and with those obtained previously for the cis- and trans-1,2-difluoroethylenes. (auth)

22649 THE KINETICS OF THE REACTION BETWEEN NEPTUNIUM(III) AND URANIUM(VI) IN AQUEOUS PERCHLORATE SOLUTIONS. Newton, T. W. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem.; 74: 1655-70(16 Apr 1970).

The overall reaction $2Np^{3+} + UO_2^{2+} + 4H^+ \rightarrow 2Np^{4+} + U^{4+} + 2H_2O$ occurs by way of three separate reactions: (a) $Np^{3+} + UO_2^{2+} \rightarrow Np^{4+} + UO_2^+$, (b) $Np^{3+} + UO_2^+ + 4H^+ \rightarrow Np^{4+} + U^{4+} + 2H_2O$, and (c) $2UO_2^+ + 4H^+ \rightarrow UO_2^{2+} + U^{4+} + 2H_2O$. The rate of the overall reaction was studied at μ = 1.0 M in acid solutions from 0.11 to 0.99 M from 0.6 to 25.1°C. The rate constants for the individual reactions (a) and (b) were determined; use was made of the previously determined values for (c). Activation parameters for the predominant net activation processes were determined from the temperature coefficients of the rates. For $Np^{3+} + UO_2^{2+} = [Np \cdot UO_2^{5+}]^*$, $\Delta F^* = 15.29$ kcal/mol (k = 39 M^{-1} sec^{-1} at 25°), $\Delta H^* = 2.60 \pm 0.16$ kcal/mol, and $\Delta S^* = -42.6 \pm 0.6$ cal/mol deg. For $Np^{3+} + UO_2^+ + H^+ = [Np \cdot UO_2 \cdot H^{5+}]^*$, $\Delta F^* = 15.29$ kcal/mol (k = 38 M^{-1} sec^{-1} at 25°), $\Delta H^* = 5.1 \pm 0.4$ kcal/mol, and $\Delta S^* = -34.1 \pm 1.2$ cal/mol deg. The equilibrium quotient for (a) was determined from the forward and reverse rates. For 1 M $HClO_4$, $\Delta F^\circ = 2.06$ kcal/mol (Q = 0.031 at 25°), $\Delta H^\circ = -8.67 \pm 0.16$ kcal/mol, and $\Delta S^\circ = -36.0 \pm 0.6$ cal/mol deg. The results for (a) and (b) are compared with the similar Pu(III)–Pu(VI), and Np(III)–Np(V) reactions. (auth)

22650 THE KINETICS OF THE OXIDATION OF PLUTONIUM(III) BY NEPTUNIUM(VI). Fulton, R. B.; Newton, T. W. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem.; 74: 1661-9(16 Apr 1970).

The reaction Pu(III) + Np(VI) → Pu(IV) + Np(V) was studied at unit ionic strength in acid perchlorate solutions from 0.06 to 1.00 M $HClO_4$ and temperatures from 0.8 to 53.2°C. At low acid concentrations and high temperatures the rate constants were corrected for the effects of disproportionation and further oxidation of Pu(IV). Two net activation processes are important: (1) $Pu^{3+} + NpO_2^{2+} \rightarrow [Pu \cdot NpO_2^{5+}]^*$ for which $\Delta F^* = 15.34$ kcal/

mol ($k_{25°}$ = 35.5 M^{-1} sec^{-1}), ΔH^* = 3.49 ± 0.05 kcal/mol, and ΔS^* = −39.73 ± 0.16 cal/mol deg; (2) $Pu^{3+} + NpO_2^{2+} + H_2O = [Pu \cdot OH \cdot NpO_2^{4+}]^* + H^+$ for which ΔF^* = 16.78 kcal/mol ($k_{25°}$ = 3.1 M^{-1} sec^{-1}), ΔH^* = 12.82 ± 0.12 kcal/mol, and ΔS^* = −13.28 ± 0.39 cal/mol deg. Chloride ion was found to cause a moderate increase in rate. The effect of ionic strength was studied from 0.24 to 3.7 M and was found to be in agreement with the extended Debye–Hückel theory. The results are compared with other analogous actinide(III)–actinide(VI) reactions. (auth)

22651 ISOTOPE EFFECT OF MOLTEN THALLOUS NITRATE IN COUNTERCURRENT ELECTROMIGRATION. Okada, Isao; Saito, Nobufusa (Tokyo Univ.). Bull. Chem. Soc. Jap.; 43: 394-7(Feb 1970).

The isotope effect of the thallous ion in the countercurrent electromigration of molten thallous nitrate was measured at 219°C. The relative internal mobility difference between $^{203}Tl^+$ and $^{205}Tl^+$, $\Delta V/V_{Tl}$, was determined to be 0.00035 ± 0.00002. The mass effect $\mu_{Tl} = (\Delta V/V_{Tl})/(\Delta M/M_{Tl})$ was calculated to be −0.035 ± 0.002, and this value was compared with those of alkali nitrates previously determined. (auth)

22652 THERMAL DIFFUSION FACTOR FOR ISOTOPIC CO. Mathur, B. P.; Watson, W. W. (Yale Univ., New Haven). (Contract AT(30-1)-2726. J. Chem. Phys.; 52: 1007-8(15 Jan 1970). (YALE-2726-556).

Thermal diffusion measurements were made on the isotopic mixture of 60% $^{13}C^{16}O$ and 40% $^{12}C^{16}O$. The reduced thermal diffusion factor is given by $\alpha_0 = \alpha_t (M_1 + M_2)/(M_1 - M_2)$, where M_1 and M_2 are the molecular weights of the heavy and light molecules, respectively. (M.C.G.)

22653 MELTING POINTS OF ETHANE AND THREE OF ITS DEUTERATED MODIFICATIONS. Burnett, Lowell J.; Muller, Burton H. (Univ. of Wyoming, Laramie). J. Chem. Eng. Data; 15: 154-7(1970).

A pulsed nuclear magnetic resonance method was used to determine both the apparent melting point and the impurity correction for samples of ethane and three of its deuterated modifications. The true melting points were found to be: CH_3CH_3 89.82°K, CH_3CD_3 89.13°K, CHD_2CHD_2 89.89°K, and CHD_2CD_3 89.82°K. (auth)

22654 U BAND IN CsI. Tanton, G. A. (Physical Sciences Lab., Redstone Arsenal, Ala.); Shatas, R. A.; Singh, R. S.; Mitra, S. S. Contract AF 19(628)6042. J. Chem. Phys.; 52: 538-42 (15 Jan 1970).

The first electronic transition of substitutional H^- and D^- ions in CsI was measured between 8 and 300°K. The absorption peak of the U band is located at 4.60 eV at 8°K. A small blue shift of 0.015 eV was observed on replacing H^- by D^-. The method of moments was employed to analyze the U-band shape. The temperature-induced broadening of the half-width and the shift of the peak is explained in terms of an effective phonon frequency representing the phonon spectrum of the host lattice. (auth)

22655 LOW-TEMPERATURE STUDIES. IV. THE PHASE TRANSITIONS OF AMMONIUM SULFATE AND AMMONIUM-d_4 SULFATE; THE NATURE OF HYDROGEN BONDING AND THE REORIENTATION OF THE NX_4^+ IONS. Schutte, C. J. H.; Heyns, A. M. (Univ. of South Africa, Pretoria). J. Chem. Phys.; 52: 864-71(15 Jan 1970).

The temperature dependence of the infrared spectra of $(NH_4)_2SO_4$ and $(ND_4)_2SO_4$ between 17 and 298°K was accurately determined. An analysis of the spectra of the high-temperature and ferroelectric phases of $(NH_4)_2SO_4$ supports the evidence of the neutron-diffraction data of Schlemper and Hamilton that there is an increase in hydrogen bonding below 223°K. From the temperature variation of the peak heights of certain bands it is shown that graphs of this type can be used to determine the presence of any phase transitions accurately. Inflection points of these curves of $(NH_4)_2SO_4$ at ~160°K are correlated with the NMR linewidth transition at 163°K; it is the first time that such a correlation has been established. The temperature dependence of ND_4^+ stretching bands indicates the possible existence of three phases in $(ND_4)_2SO_4$ (transition temperatures 225 and ~223°K). The torsional mode of the NH_4^+ ions was identified; there is no evidence that the ion rotates "freely" at any temperature. (auth)

22656 ELECTRONIC STATES OF HEAVILY DOPED MOLECULAR CRYSTALS: NAPHTHALENE. I. THEORETICAL. Hong, Hwei-kwan; Robinson, G. Wilse (California Inst. of Tech., Pasadena). Contract DA-31-124-ARO-D-370. J. Chem. Phys.; 52: 825-48(15 Jan 1970).

The energy spectrum of heavily doped molecular crystals was treated in the Green's function formulation. The mixed-crystal Green's function was obtained by averaging over all possible impurity distributions. The resulting Green's function, which takes the form of an infinite perturbation expansion, was further approximated by a closed form suitable for numerical calculations. The density-of-states functions and optical spectra for binary mixtures of normal naphthalene and deuterated naphthalene were calculated using the pure-crystal density-of-states functions. The results showed that, when the trap depth is large, two separate energy bands persist, but when the trap depth is small only a single band exists. Furthermore, in the former case it was found that the intensities of the outer Davydov bands are enhanced whereas the inner bands are weakened. Comparisons with previous theoretical calculations and experimental results are also made. (auth)

22657 PHOTOELECTRON SPECTRA OF ETHYLENE AND ETHYLENE-d_4. Branton, G. R.; Frost, D. C.; Makita, T.; McDowell, C. A.; Stenhouse, I. A. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 52: 802-6(15 Jan 1970).

The photoelectron spectra of ethylene and ethylene-d_4 were measured using a new high-resolution spectrometer and the 584-Å helium resonance line as a light source. Five ionization potentials were observed for each compound. Vibrational structure associated with the transitions leading to the first and fourth ionization potentials was resolved, and it was possible to assign the corresponding vibrational modes. The photoelectron spectrum of neon, obtained with the 537-Å line from the same light source, is also presented. (auth)

22658 OPTICALLY DETECTED ^{35}Cl AND ^{37}Cl HYPERFINE AND NUCLEAR QUADRUPOLE INTERACTIONS IN EXCITED TRIPLET STATE IN ZERO FIELD. Buckley, M. J.; Harris, C. B. (Univ. of California, Berkeley). Chem. Phys. Lett.; 5: 205-13(1 Apr 1970).

The zero field optical detection of the electron spin resonance and Cl ENDOR of 8-chloroquinoline in its $3(\pi,\pi^*)$ state is reported. The observed data are interpreted in terms of a spin-hamiltonian which includes the ^{14}N, ^{35}Cl, and ^{37}Cl nuclear-electron hyperfine and nuclear quadrupole interactions. Values for these parameters are obtained for the excited triplet state. (auth)

22659 VIBRATIONAL RELAXATION OF HYDROGEN HALIDES: DBr AND DI. Breshears, W. D.; Bird, P. F. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 52: 999-1000(15 Jan 1970).

Densitometric measurements of the vibrational relaxation of DBr and DI were measured behind incident shock waves in the approximate temperature range 700 to 2000°K. The curve for each of the deuterated species lies below that of its hydrogen analog. This indicates that rotation–vibration energy transfer plays a significant role in the vibrational relaxation of the hydrogen halides. (M.C.G.)

22660 RELAXATION OF THE ASYMMETRIC STRETCHING VIBRATION OF CO_2 BY COLLISIONS WITH H_2O, D_2O, AND HDO. Heller, Donald F.; Moore, C. Bradley (Univ. of California, Berkeley). J. Chem. Phys.; 52: 1005-6(15 Jan 1970).

The vibrational relaxation of the asymmetric stretching of CO_2 by H_2O, D_2O, and HDO was measured by the laser-excited vibrational fluorescence technique. Processes likely to contribute to the observed relaxation rates are listed. (M.C.G.)

22661 HIGH-TEMPERATURE APPROXIMATIONS FOR KINETIC ISOTOPE EFFECTS. Weston, Ralph E. Jr. (Brookhaven National Lab., Upton, N. Y. Univ. of California, Berkeley). J. Chem. Phys.; 52: 1016-17(15 Jan 1970).

It is shown that isotope effects can be formulated differently from the Tschuikow–Roux and Macdonald proposals, with certain conceptual advantages and a decrease in the computational effort. (M.C.G.)

22662 COMMENT ON HIGH-TEMPERATURE APPROXIMATIONS FOR KINETIC ISOTOPE EFFECTS. Macdonald, Digby D.; Tschuikow-Roux, E. (Univ. of Calgary, Alberta). J. Chem. Phys.; 52: 1017-18(15 Jan 1970).

22663 CYCLOPROPANES. XXV. THE CYCLOPROPYL ANION. Walborsky, H. M.; Motes, John M. (Florida State Univ., Tallhassee). J. Amer. Chem. Soc.; 92: 2445-50(22 Apr 1970).

The rate of hydrogen–deuterium exchange and rate of racemization of 2,2-diphenylcyclopropylnitrile and its acyclic analog 2-methyl-3, 3-diphenylpropionitrile were investigated. The cyclic nitrile exhibits a very high degree of retention of configuration in methanol, t-butyl alcohol, and methanol–dimethyl sulfoxide (10:90) using sodium alkoxide as the base. In contrast, extensive racemization was observed for the acyclic nitrile. Small kinetic isotope effects ($k_H/k_D \approx 2$) were observed with both nitriles. These observations in conjunction with results of ancillary studies are interpreted by us to show the proton abstraction by base is not rate determining in both the exchange and racemization reaction of 2,2-diphenylcyclopropylnitrile. (auth)

22664 VARIATION OF ^{14}C ISOTOPE EFFECT WITH SUBSTITUENT AND THE MECHANISM OF THE m-CHLOROPERBENZOIC ACID OXIDATION OF LABELED para-SUBSTITUTED ACETOPHENONES. Palmer, Billy W.; Fry, Arthur (Univ. of Arkansas, Fayetteville). J. Amer. Chem. Soc.; 92: 2580-1 (22 Apr 1970).

Results of a series of kinetic and isotope effect measurements on the m-chloroperbenzoic acid oxidation of para-substituted carbon-14-labeled acetophenones to para-substituted carbon-14 labeled phenyl acetates are presented. The para substituents are CH_3O, CH_3, H, Cl, and CN. An explanation is offered for the variation of isotope effect with substituent, which is larger than variations observed previously. (J.G.B.)

Radiation and Nuclear Chemistry

Refer also to abstracts 22727, 22749, 22754, 22755, 23037, 23038, 23117, 23118, and 24784.

22665 (AECL-3521) CHEMISTRY AND MATERIALS DIVISION. Progress Report, October 1-December 31, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 104p. (PR-CMa-11). Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Research progress is reported on the following topics: ion penetration, electron microscopy in solid state studies, radiation damage and deformation, activation analysis, nuclear chemistry, superconductivity, analytical chemistry, fuel analysis, radioactivity measurements, heavy water analysis, electrochemical H/D separation, mass spectrometry, radiation chemistry, isotope chemistry, surface chemistry, ceramic studies, metal physics, fission processes, and oxide film studies. (M.C.G.)

22666 (CEA-R-3933) STUDY OF COLLOIDAL MOLYBDENUM BLUE. Gratot, Irene; Beydon, Jacqueline (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 19p. (In French). Dep. CFSTI (U. S. Sales Only).

The preparation of colloidal molybdenum blue by photochemical reduction of molybdate by formaldehyde was studied, and the concentration of the reagents and the time of exposure to the reducing radiations were determined. With γ radiation of ^{60}Co or ^{137}Cs, unlike ultraviolet radiation, it is possible to carry out the preparation with a good yield, even for high molybdate concentrations. The colloid is stable at a pH lower than 3 and as such could not be used for therapeutic purposes. It was not possible to separate ^{99m}Tc by β recoil from a colloid labeled with ^{99}Mo. (France)

22667 (COO-690-38) CHEMICAL AND CONFORMATIONAL STUDIES OF GAMMA IRRADIATED LYSOZYME. Herbert, Sarah Mary (Colorado Univ., Boulder). 1969. 81p. Dep. CFSTI. Thesis.

The phosphate soluble fraction of γ-irradiated lysozyme can be separated by column chromatography into a number of protein components. The chemical and physical properties of a major fraction, P3-I, eluting very close to native lysozyme was examined. The free radical distribution in the irradiated phosphate soluble fractions including P3-I was determined by labeling with tritiated hydrogen sulfide (HTS). The protein fraction, P3-I, showed considerable homogeneity on Bio-Rex 70 chromatography and could not be separated from the native protein. The disc gel electrophoresis experiments performed on the irradiated fraction P3-I under a variety of conditions indicate a small distribution of either charge or molecular weight. The results of the reaction of the phosphate soluble portion of irradiated lysozyme with HTS show that the proteins resulting all have about the same level of radical formation even though they differ widely in enzyme activities. Sedimentation velocity measurements on native lysozyme and P3-I indicate that the latter has a distinctly different average shape than the native protein. The enzyme activity of the irradiated protein P3-I is 95% of that of the native enzyme. Optical rotatory dispersion spectra show very little difference between P3-I and native lysozyme down to 220 nm. Ultraviolet absorption spectroscopy shows several differences between P3-I and native lysozyme. There are changes in the environment of the peptide backbone as well as of the aromatic chromophores. These results suggest that P3-I is not a homogeneous material but consists of molecules which have been damaged in many ways, and in which no one molecule has suffered extensive damage. Both heat and pH perturbation spectra of the irradiated protein, when compared to native lysozyme, show that part of the conformational damage to this irradiated molecule can be "corrected" by denaturation and renaturation. These data, together with the uv absorption spectra after denaturation by heat and alkaline pH, indicate that there are two levels of conformational damage to P3-I. There is conformational damage that is not reversible and presumed caused by chemical changes and there is reversible damage presumed not caused by chemical effects. Two mechanisms are proposed for the reversible conformational damage. One involves the formation of a "hot spot" during irradiation whereby very limited regions of the protein are subject to a rise in effective temperature sufficient to give atomic mobility within the solid molecule. The other mechanism involves the radiation formation of charged groups in hydrophobic centers of the protein that result in rearrangement of the hydrophobic groups to accommodate the charge. A mechanism for chemical damage from gamma irradiation of proteins is proposed involving independent cumulative inactivation of amino acid residues. (auth)

22668 (EIR-173) INVESTIGATION OF THE RECOIL CHEMISTRY OF ^{19}O AND OF RADIOLYSIS OF WATER BY REACTOR RADIATION. Blaser, W. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Feb 1970. 79p. (In German). Dep. CFSTI (U. S. Sales Only).

The recoil chemistry of ^{19}O and its effects on the radiolytic processes in pure water under reactor irradiation were investigated. Calculations yielded a recoil energy of 441.5 eV for the ^{19}O atom and an increase in the internal energy of the $H_2{}^{19}O$ molecule of 42.1 eV, which is enough to completely split off the ^{19}O atom. It was concluded that in about 50% of the cases the thermalizing tracks of ^{19}O depend on molecular combinations $^{19}O-O(H_2O_2, O_2H, O_2)$. A large part of the products with $^{19}O-O$ bonds results from reactions of H radicals and hydrated electrons with $H_2{}^{19}O$ in water radiolysis. (M.C.G.)

22669 (FOA-4-4419) AN INVESTIGATION REGARDING THE RADIOLYTIC GAS RELEASE DURING STORAGE OF PLUTONIUM CONTAINING MATERIALS. Oesterdahl, B. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar 1970. 9p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

Water solutions containing plutonium evolve gas caused by a radiolysis of water in the presence of alpha radiations from plutonium. The gas yield varies depending on the ions and molecules present in the solution. The number of possible reactions in a solution that may not be a very simple compound are so great that a theoretical calculation is very complicated. Some experimental work is reviewed. It was found that the amount of gases evolving from radiolysis is a potential hazard when sealed containers are used. (auth) (Sweden)

22670 (NYO-3558-21) PROGRESS REPORT [ON RADIATION DAMAGE PROCESSES AT THE MOLECULAR LEVEL], FEBRUARY 1970. (Roswell Park Memorial Inst., Buffalo, N. Y.). Contract AT(30-1)-3558. 4p. Dep. CFSTI.

Electron-nuclear double resonance (ENDOR) studies were made on free radicals formed in irradiated ice. It was found that OH radicals are produced in 3 distinct environments. The creation of radical pairs from uv dissociation of molecules was studied. ENDOR spectroscopy was used to further document the structure of negative ions formed in carboxylic acids by ionizing radiation. Effects due to ionization and molecular excitation were studied in irradiated dibenzoyl disulfide. (M.C.G.)

22671 (ORO-2418-7) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Final Research Report. Sears, W. C. (Georgia Univ., Athens. Dept. of Physics). 30 Aug 1969. Contract AT(40-1)-2418. 117p. Dep. CFSTI.

Studies were made on the changes in molecular structure produced by high-energy radiation on different organic polymers, and also on the mechanism of radioinduced growth and decay of unsaturation and changes in polymer crystallinity, crosslinking, and scission. The structural changes were determined by measuring the ir spectra of polymer films with a Beckman IR-4 infrared spectrophotometer before and after irradiation. Gamma dose rates varied from 1.3×10^6 to 5.4×10^6 R/hr. Data are presented in tabular and graphic form. (P.C.H.)

22672 (ORO-3349-7) RADIATION INDUCED LUMINESCENT PROCESSES IN GASES. Progress Report. Llewellyn, J. A. (Florida State Univ., Tallahassee). 1 Dec 1969. 112p. Dep. CFSTI.

Studies of luminescence as a means of establishing the sequences and relative probabilities of the events that result in the transfer of energy from an energetic particle to a gaseous substrate are described. A program to catalog the radiative excited states produced in N_2 under bombardment has been in progress surveying the emission range from 500 to 5000A. Some eight molecular systems and ten atomic systems have been identified and relative intensities and pressure-dependent intensities have been measured. In these experiments, the spatial distribution of luminescence in-

duced by an electron beam is related first to effects of the primary beam and these are separated from those due to subsequent electron-induced, collision, and other energy transfer processes. The role of primary versus secondary processes was assessed, in part, based on measurements of the dependence of electron-impact luminescent cross sections on the energy of the impacting electron. The slowing down of energetic electrons in He has also been examined theoretically. (auth)

22673 (UJV-2299-CH) PRODUCTION OF CARRIER FREE ^{52}Mn. Hruby, J.; Knobloch, V.; Mudrova, B.; Svoboda, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 65p. (In Czech). Dep. CFSTI (U. S. Sales Only).

Studies undertaken with the aim to find out optimal methods of ^{52}Mn production by irradiation in the U-120 cyclotron are described. The production reaction ^{52}Cr(d,2n)^{52}Mn is used. Different shapes of targets (rectangular, loop-shape, cylindrical) as well as different methods of chromium target layer preparation and pre-irradiation treatment were tried. The most suitable proved to be a cylindrical copper target electrolytically covered with a 0.35-mm layer of chromium annealed at 300°C in a vacuum for 8 hours. Such targets can be irradiated without detectable damage with a beam of deuterons up to 350 μA. The thick-target-yields are 70 to 99% of the physically attainable value. Some efforts were undertaken to find out the best way of dissolving the target. Separation of ^{52}Mn from individual side products (^{48}V, ^{51}Cr) and the bulk amount of chromium in the irradiated target was studied. The most suitable proved to be manganese extraction with thenoyltrifluoroacetone (TTA) into ethyl acetate from an aqueous solution at pH = 7 to 9. The efficiency of chemical separation reaches 95%. Methods for analysis of the final product for radioactive and chemical purity were developed. (auth)

22674 RADIOLYSIS OF GASEOUS TRIFLUOROMETHYL IODIDE. Shah, P. G. (ICIANZ Central Research Labs., Ascot Vale, Australia); Stranks, D. R.; Cooper, R. Aust. J. Chem.; 23: 253-60(Feb 1970).

Gamma radiolysis of gaseous CF_3I produced CF_4 (G = 0.77), C_2F_6 (G = 3.0), C_2F_4 (G = 0.89), and I_2 (G = 4.08). In the presence of nitric oxide or bromine, the fluorocarbon products were removed and high yields of scavenged products were obtained. In the presence of NO, G(I_2) was 11.6; in the presence of Br_2, G(CF_3Br) was 20.1. Competition experiments using Br_2 and Cl_2 indicated that thermal free radicals are responsible for a major part of the decomposition mechanism. The high radical yields may be due to short chain reactions involving excited iodine atoms or recombination of ion clusters. (auth) (Australia)

22675 EMISSION FROM BENZENE EXCITED BY PULSE RADIOLYSIS. Horrocks, A. R. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 48: 1000-2(15 Mar 1970).

The emission spectra from deaerated benzene solutions of varying concentration, excited by 3 nanosecond duration electron pulses at dose rates of 10^{13} rads/s are described. These compare favorably with the photoexcited spectra for similar benzene systems. The effects of chloroform and oxygen on the emission from liquid benzene are reported. (auth) (Canada)

22676 RADIOLYSIS OF ETHANE. I. LIQUID PHASE AT 195°K WITH ADDED CYCLOPENTENE. Holland, P. T.; Stone, J. A. (Queen's Univ., Kingston, Ont.). Can. J. Chem.; 48: 1078-83(1 Apr 1970).

The radiolysis of liquid ethane at 195°K gave as major products H_2, C_2H_4, and n-C_4H_{10}. Minor products were CH_4 and C_3H_8. The initial yields of H_2 and C_2H_4 could only be determined indirectly due to the high rate of H-atom addition to product ethylene. c-C_5H_8 in low concentration effectively scavenged H atoms and hence protected C_2H_4. The derived initial yields were: G(H_2) = 5.97, G(C_2H_4) = 2.96, G(CH_4) = 0.44, and G(C_2H_6) = 0.55. The yields of scavengeable H atoms and $\cdot C_2H_5$ radicals were 2.29 and 5.81, respectively. The problem of direct measurement of initial G(H_2) values for saturated hydrocarbons at low temperatures is discussed. (auth) (Canada)

22677 PRIMARY PROCESSES OF HYDROGEN FORMATION IN THE GAS- AND LIQUID-PHASE RADIOLYSIS OF PROPANE. Fujisaki, Noboru; Shida, Shoji; Hatano, Yoshihiko (Tokyo Inst. of Tech.). J. Chem. Phys.; 52: 556-62(15 Jan 1970).

The yield of hydrogen formed in the gas- and liquid-phase radiolysis of propane has been measured in the presence of a "radical scavenger" (C_2H_4) and an electron scavenger (N_2O or SF_6). Further, the isotopic compositions of the hydrogen formed in the gas-phase radiolyses of $C_3H_8-C_3D_8$, C_3H_8-4 mole % $SF_6-C_3D_8$, and C_3H_8-4 mole % $C_2H_4-C_3D_8$ mixtures and also those in the liquid-phase radiolyses of $C_3H_8-C_3D_8$, $C_3H_8-0.4\underline{M}$ $SF_6-C_3D_8$, and $C_3H_8-0.2\underline{M}$ $C_2H_4-C_3D_8$ mixtures have been measured to determine the unimolecular fraction of hydrogen for each mixture. Combining these results, the yields of six primary processes by which hydrogen is formed have been evaluated. The results for the gas-phase radiolysis G (thermal hydrogen atom), G (hot hydrogen atom), and G (unimolecular hydrogen) were, respectively, 2.5, 0.9, and 1.4 by direct excitation and ionization, and that G (thermal hydrogen atom and hot hydrogen atom) and G (unimolecular hydrogen) were, respectively, 1.9 and 0.7 by neutralization. For the liquid-phase radiolysis G (thermal hydrogen atom), G (hot hydrogen atom), and G (unimolecular hydrogen) were, respectively, 0.9, 1.2, and 0.4 by direct excitation and ionization and 0.6, 0.7, and 1.0 by neutralization with probable errors of ±0.2. The G-values of the six primary processes for propane in the liquid-phase radiolysis were almost the same as those for n-butane previously reported. A possible role of hot hydrogen atoms has been pointed out in the gas-phase as well as in the liquid-phase radiolysis of propane. It is also suggested that ethylene scavenges with high efficiency not only thermal hydrogen atoms but also positive ions, especially in the gas phase. (auth)

22678 IRRADIATION OF XENON–PROPANE AND ARGON–PROPANE MIXTURES WITH γ RAYS AND 21.2-eV PHOTONS. Lias, S. G.; Rebbert, R. E.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys.; 52: 773-83 (15 Jan 1970).

Mixtures of xenon or argon with propane (20 : 1) were irradiated in the presence of radical scavengers by γ rays and by 21.2-eV photons from a helium resonance lamp. The ion-pair yields of products originating from ionic fragmentation reactions or ion–molecule reactions are derived from isotopic analysis of product molecules formed in $C_3D_8-C_3H_8$ mixtures or in $CD_3CH_2CD_3$. At a given pressure, there were only small differences between the radiolysis and photolysis in the modes of dissociation of parent propane ions formed by charge transfer with a particular rare gas. Higher-energy ionic fragmentation processes were quenched when the pressure was increased; in the case of xenon–propane mixtures it was demonstrated that the parent ion yield increased as primary fragmentation processes were quenched. In the irradiated argon–propane–scavenger mixtures, isotope effects on the ionic fragmentation of the excited deuterated fragment ions were pronounced. The decomposition of neutral propane molecules excited to lower resonance states accounted for not more than 10 to 12% of the product-forming processes in the xenon mixtures. (auth)

22679 RADIATION GRAFT COPOLYMERIZATION OF ACRYLAMIDE ON POLYOLEFINS. Hayakawa, Kiyoshi; Kawase, Kaoru; Yamakita, Hiromi (Government Industrial Research Inst., Nagoya, Japan). Radioisotopes (Tokyo); 19: 81-6(Feb 1970).

Several techniques of grafting applicable to the polyolefines–acrylamide system were studied. In the simultaneous irradiation technique in acetone solutions of acrylamide, most of the monomer was consumed in the homopolymerization, and the efficiency of grafting was very low. The low-temperature preirradiation technique brought about a high extent of grafting without homopolymer formation. The vapor-phase simultaneous irradiation technique using the sublimation vapor was applicable to the polyolefines either by γ rays or by uv rays, but a much higher dose was required in this technique than in the simultaneous irradiation grafting in solution. It was also possible to graft copolymerize by the preirradiation technique using sublimation vapor, but the extent of grafting was very low. The compositions of the grafted products were also examined in several instances. (auth)

22680 RADIOLYSIS OF ASCORBIC ACID IN AQUEOUS SOLUTION. Ogura, Hajime; Murata, Moriyasu; Kondo, Masaharu (Tokyo Metropolitan Univ.). Radioisotopes (Tokyo); 19: 89-91 (Feb 1970).

Studies were made on the ^{60}Co γ radiolysis of ascorbic acid in deaerated aqueous solutions with no additives. The reactivity of H atoms toward ascorbic acid was determined by the scavenger method. The radiolytic yield of ascorbic acid, AH_2, expressed as G-value was 3.6. Yields of dehydroascorbic acid, G(A), and hydrogen, G(H_2), were 1.9 and 0.49, respectively. Mechanisms for the yields are discussed. (P.C.H.)

22681 THE RECOVERY OF ^{237}Np AND ^{238}Pu. Groh, H. J.; Schlea, C. S. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Progr. Nucl. Energy, Ser. III; 4: 507-47(1970).

A summary is given of the chemical technology associated with the production of ^{237}Np and ^{238}Pu, under the following headings: nuclear reactions; radiation properties; solvent extraction chemistry (distribution data; oxidation-reduction reagents; reaction equilibria; reaction kinetics); ion exchange chemistry (anion exchange; cation exchange); recovery of ^{237}Np from enriched uranium (solvent extraction process at Savannah River; ion exchange process at ORNL); recovery of ^{237}Np from natural uranium (Purex process at Savannah River; Purex process at Hanford; redox pro-

cess at Hanford); recovery of ^{238}Pu from irradiated ^{237}Np (dissolution and ion exchange separations; finishing processes for ^{237}Np and ^{238}Pu; ^{237}Np target preparation). (41 references.) (UK)

22682 EFFECTS OF CERTAIN FACTORS ON THE RADIATION-INDUCED POLYMERIZATION OF METHYL METHACRYLATE. Detrick, Carl A.; Kelly, James L. (Univ. of Virginia, Charlottesville). Ind. Eng. Chem., Process Design Develop., 9: 191-4(Apr 1970).

The effects of hydroquinone, oxygen, and acetone on the radio-induced polymerization of methyl methacrylate were studied. Irradiations were performed in a medium-intensity gamma radiation chamber created by neutron activation of ^{55}Mn. Resultant radiation dose rates varied between 1.4 and 3.2×10^5 Rads per hour initially and diminished with a 2.58-hour half-life. Hydroquinone acted as an ideal inhibitor, oxygen as an ideal retarder. Their effects were independent of one another. Solutions of MMA in acetone exhibited the "simple dilution effect." The effects of hydroquinone and oxygen in MMA–acetone were similar to those in bulk MMA. Conversion of the monomer for a given dose was independent of dose rate for dose rates in the range 1×10^4 to 3.2×10^5 Rads per hour. (auth)

22683 RADIATION-INITIATED SIDE-CHAIN CHLORINATION OF TOLUENE. I. KINETIC INVESTIGATIONS. Yang, J. Y. (Western New York Nuclear Research Center, Inc., Buffalo); Thomas, C. C. Jr.; Cullinan, H. T. Contract AT(30-1)-3864. Ind. Eng. Chem., Process Design Develop.; 9: 214-22(Apr 1970).

The radioinduced side-chain chlorination of toluene was investigated using accelerated electrons as the radiation source. The reaction was carried out to complete side-chain chlorination within the temperature range from 80 to 150°C. Contamination by-products resulting from substitution and addition at the aromatic nucleus were small. The conversion of toluene to benzotrichloride follows three consecutive reaction processes and the yield efficiencies are approximately inversely proportional to the square root of the radiation dose intensities. At reasonable dose intensities, the yield efficiencies are sufficiently high to merit considerations for commercial application of a radiation reactor for the production of benzotrichloride. (auth)

22684 RADIATION-INITIATED SIDE-CHAIN CHLORINATION OF TOLUENE. II. CONTINUOUS REACTOR DESIGN. Cullinan, H. T. (State Univ. of New York, Buffalo); Rhambia, H.; Yang, J. Y.; Thomas, C. C. Jr. Contract AT(30-1)-3864. Ind. Eng. Chem., Process Design Develop.; 9: 222-9(Apr 1970).

A theoretical investigation of the design of a chemical reactor for the continuous β-induced side-chain chlorination of toluene to produce benzotrichloride is described. The reactor configuration considered is a liquid-phase fluidized bed containing active beta-source particles maintained in a fluidized condition by the upward reactants feed and recycle flow. A model was developed based on empirical expanded bed characteristics, gross G-value kinetics, empirical radiation energy utilization efficiency, and an axial dispersed plug flow equation. Results for energy utilization efficiency, reactor geometry, and source strength requirements are presented. The problem of source attrition is discussed. (auth)

22685 FORMATION OF AMINO ACIDS FROM AQUEOUS MIXTURES OF α-KETO ACIDS AND AMMONIA BY γ-IRRADIATION. Maduda, Kimiko; Rai, Tokan; Shinagawa, Mutsuaki (Osaka Univ.). Radioisotopes (Tokyo); 19: 77-80(Feb. 1970).

The formation of amino acids from several α-keto acids by γ irradiation in aqueous ammonia solution was investigated. The yield of every amino acid was studied as a function of radiation dose as well as the concentrations of α-keto acid and ammonia. The reaction process was proposed as the reductive amination of α-keto acids induced by irradiation. On the amination of pyruvic acid, alanine was formed (G = 0.75). In the amination of the phenylpyruvic acid, phenylalanine was obtained (G = 0.5). The amination of α-keto-isovaleric acid and α-keto-isocapronic acid led to the formation of valine (G = 0.84) and leucine (G = 0.68), respectively. Tryptophan was found as the corresponding amino acid by amination of indolpyruvic acid (G = 0.45). (auth)

22686 AN ELECTRON SPIN-RESONANCE STUDY OF γ-IRRADIATED LITHIUM DL-LACTATE. Whelan, D. J. (Defense Standards Labs., Melbourne). Aust. J. Chem.; 23: 37-41(Jan 1970).

An ESR study of single crystals of lithium DL-lactate irradiated at room temperature indicated that the free radical $CH_3\dot{C}(OH)CO_2^-Li^+$ is trapped in the crystalline matrix, and from the magnitude of the isotopic hyperfine splitting parameters of the methyl protons (53.0 MHz) and the hydroxyl group (9.3 MHz) it was inferred that the extensive polarization of the orbital containing the unpaired electron into the carboxylate and hydroxyl groups occurs. Experiments on powdered lithium DL-lactate showed that this free radical is formed at the end of a reaction sequence. When lithium DL-lactate was irradiated at 77°K the low temperature ESR pattern originated from $CH_3\dot{C}H\,CO_2^-Li^+$ and it was only on warming the sample that the fragment $CH_3\dot{C}(OH)CO_2^-Li^+$ was formed. A similar reaction sequence has also been noted in irradiated glycolic acid. (auth) (Australia)

22687 RADIONUCLIDES FROM IRRADIATED NUCLEAR FUEL. Lopez-Menchero, E. (EUROCHEMIC, Mol, Belg.). Technical Meeting No. 7/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (NP–18184; ETR–251).

See CONF-691018.

The expected contents of nuclides in thermal power reactor spent fuel are given, along with published predictions on their future prices and production costs. A review of the recovery processes now known is presented and the need for integrating the byproduct recovery and the radioactive waste management concepts is emphasized. Some action lines for promoting the market for fuel processing byproducts in Europe are also defined. (auth)

22688 THERMODYNAMIC PROPERTIES AND IRRADIATION STUDIES OF HIGH POLYMERS. Currie, James Alfred. Evanston, Ill.; Northwestern Univ. (1969). 192p.

Thesis.

Differential scanning calorimetry, DSC, was used to measure the specific heat of various polystyrene isomers and to investigate the exothermic heat effects in conjunction with free radical recombination in irradiated linear polyethylene. Equipment is described along with modifications and special techniques adopted for recording and analyzing the data. Specific heats of broad and narrow molecular weight distribution atactic, amorphous isotactic, and partly crystalline isotactic polystyrene samples were measured over the temperature range 320 to 525°K for a total of 17 samples and in the case of atactic samples as a function of the previous thermal and mechanical treatments. On heating through the glass transition interval, a distinct depression of the initial specific heat was observed for those atactic polystyrene samples containing residual strain as the result of melt extrusion and quenching pretreatments. However, the slope of these specific heat curves in the liquid is greater than that measured for identical polystyrene samples annealed at elevated temperatures before making the measurements. Quenched (amorphous) and semi-crystalline isotactic polystyrene also exhibit specific heat curves that are very dependent on the exact heating schedule employed in making the measurements. Crystallization above the glass transition temperature (T_g) can take place at various temperature ranges depending on the length of time the sample is in residence at temperatures above the glass transition interval. Analytical and graphical estimates of T_2, that temperature to which the glass transition would have to be lowered so that the entropy per gram of the liquid phase becomes equal to that of the crystal, yield 260°K and 275 ± 15°K respectively, thereby confirming previous results from our laboratory that indicated $T_g - T_2$ is greater than the 50 ± 5 degrees given by other authors as a universal value. The decay of free radicals in linear polyethylene irradiated up to doses of 700 Mrad was investigated by a differential enthalpy analysis technique employing the DSC. Exothermic heats of reaction due to free radical recombination yielded an overall G (Free Radicals) of about 0.4 based on the heat of reaction of two allyl free radicals being –34.2 Kcal. $mole^{-1}$. The exothermic heat effects were superimposed on the curves representative of the fusion process for the polyethylene samples used, thus confirming similar observations of others using ultraviolet and infrared spectroscopy to follow the decay of allyl and higher order polyenyl free radicals under similar heating conditions. A computer program for the analysis of specific heat by DSC is appended. (Diss. Abstr. Int., B)

22689 RADIOLYTIC POLYMERIZATION OF METHYL METHACRYLATE IN A WOOD MATRIX–HEAT TRANSFER CONSIDERATIONS. Barthelemy, Darryl Julien. Baton Rouge, La.; Louisiana State Univ. (1969). 136p.

Thesis.

A mathematical model of the wood-plastic system with predictive capabilities to follow the course of the polymerization with respect to local temperature rise from the exothermic reaction and monomer concentration as functions of time and position within the specimen was developed. A rate expression was first derived for the kinetics of the radiolytic polymerization, from which a model for the system was developed on the basis of an overall energy balance. It was assumed for the model that: the wood matrix acts only as a diluent for the monomer and does not influence the chemistry of the reaction, heat transfer takes place by conduction in the radial direction only, the thermal properties of the system can be represented by weighted averages of the individual properties of the monomer and wood matrix, the initial concentra-

tion of monomer is uniform through the specimen, and the surface temperature of the specimen does not change with time. A MIMIC program for the IBM 360 computer is employed for solution of the model equations, using experimental and literature values for the various constants. The overall order of the radiolytic polymerization, temperature-independent rate constant, dose-rate dependence, and activation energy required for evaluation of the model are resolved from conflicting literature data by a detailed study of the bulk radiolytic polymerization with purified monomer. These values are, respectively, order = apparent zero, $k_{01} = 0.12$, $k_{02} = 1.10$, $\xi = 0.5$, and $E^* = 3.8$ Kcal/g-mole. Experimental data for wood-plastic specimens and computed curves for the model were compared for temperature as a function of both time and radial position. It was concluded that the mathematical model provides a reasonable first step in the description of the course of radiolytic polymerization of methyl methacrylate in a wood matrix. (Diss. Abstr. Int., B)

22690 ELECTRON SPIN RESONANCE STUDIES OF POLYCARBONATE IRRADIATED BY γ RAYS AND ULTRAVIOLET LIGHT. Hama, Yoshimasa; Shinohara, Kenichi (Waseda Univ., Tokyo). J. Polym. Sci., Part A-1; 8: 651-63(Mar 1970).

Paramagnetic species produced in polycarbonate (PC) by γ- or ultraviolet irradiation were investigated by ESR. In γ-irradiation, scissions of carbonate groups in the main chain occurred. ESR spectra ($g = 2.003_4$) composed of a sharp singlet, some broad singlets, and small signal with hyperfine structure were obtained, and they were assigned to trapped electrons, positive radical ions, phenoxy-type free radicals, phenyl radicals, and $-O-C_6H_4-C(CH_3)_2$ radicals. The G value for total yields of paramagnetic species at 77°K is 1.8. The percentages of CO and CO_2, the dominant gases evolved, are 65.4 and 33.8%, respectively. In ultraviolet irradiation, energy is absorbed selectively at the surface region. The surface region becomes insoluble in methylene chloride because of crosslinking of phenyl groups. The ESR spectrum obtained at 77°K is a broad singlet and assigned to phenoxy-type free radicals, phenyl radicals, and polyenyl-type free radicals. Some differences in effects of γ- and ultraviolet irradiation of PC are discussed. (auth)

22691 ELECTRON SPIN RESONANCE STUDY OF POLY-3,3-BIS(CHLOROMETHYL)OXETANE IRRADIATED WITH ELECTRON BEAMS AND ULTRAVIOLET LIGHT. Tsuji, Kozo; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). J. Polym. Sci., Part A-1: 8: 583-91(Mar 1970).

Poly[3,3-bis(chloromethyl)oxetane] (poly-BCMO) was irradiated at −196°C with electron beams and ultraviolet light, and observed ESR spectra were compared. A three-line spectrum (coupling constant of about 21 gauss) and a two-line spectrum (coupling constant of about 18 gauss) were observed after irradiation with electron beams in vacuo. They were attributed to free radicals $-\dot{C}(CH_2-)_2$ and $-\dot{C}H-O-$, respectively. On the other hand, a three-line spectrum (coupling constant of about 20 gauss) and an asymmetric singlet spectrum were observed after ultraviolet irradiation in vacuum. They were assigned to free radicals $-\dot{C}(CH_2-)_2$ and $-CH_2-O\cdot$, respectively. Mechanisms of radical formation are discussed in each case. When poly-BCMO was irradiated with electron beams at −196°C in the presence of air, peroxy radicals were produced after subsequent treatment at −78°C. The reaction between alkyl radicals and oxygen molecules was found to be diffusion-controlled. (auth)

22692 THE GAMMA-RADIOLYSES OF SILANE AND SILANE–ETHYLENE MIXTURES. Schmidt, John Francis Jr. University Park, Pa.; Pennsylvania State Univ. (1969). 123p.

Thesis.

The products of the γ-radiolysis of silane and silane–ethylene mixture were determined qualitatively by mass spectrometry and quantitatively by gas chromatography. The yields of the observable products of the radiolysis of 50 torr of silane at 25° were $G(H_2) = 17.0$ and $G(Si_2H_6) = 5.3$. The formation of polymeric silicon hydride was deduced by the requirement of mass balance. The addition of small amounts of the free radical scavengers ethylene and nitric oxide resulted in the production of only 65% and 30% of the unscavenged yields of hydrogen and disilane, respectively. It is believed, therefore, that the following reactions, $H + SiH_4 \rightarrow H_2 + SiH_3$ and $SiH_3 + SiH_3 \rightarrow Si_2H_6$, account for approximately 35% of the hydrogen product and 70% of the disilane product. Considering the large rate constants of the ion-molecule reactions of silane occurring in the mass spectrometer, it is likely that ion-molecule reactions also play a key role in irradiated silane. Reactions can be written to represent a chain formation of both products disilane and hydrogen. The proposal is made that ion-molecule reactions such as $Si_2H_5^+ + SiH_4 \rightarrow Si_3H_9^+ + H_2$ occur at the walls of the reaction vessel resulting in buildup of polymeric material. Hydrogen, which was observed to increase fourfold in the presence of quartz "wool," is also a product of the above ion-molecule reaction at the surface. The addition of ethylene to the silane radiolysis system resulted in the chromatographic detection of several additional radiolysis products, viz., ethylsilane and diethylsilane, which were identified by comparison of retention times and mass spectral cracking patterns with those of known standards. The yields of the products of 50 torr of silane and 10 torr of ethylene are $G(C_2H_5SiH_3) = 31.2$, $G(H_2) = 10.7$, $G(C_2H_5SiH_2C_2H_5) = 7.8$, and $G(Si_2H_6) = 1.6$. The 1,2-telomer was identified as diethylsilane, rather than n-butylsilane, by means of mass spectral analysis. Several other compounds of higher molecular weights were formed in small amounts and were tentatively identified. The addition of as little as 0.6% nitric oxide to the silane–ethylene radiolysis resulted in the complete suppression of ethylsilane formation. Such behavior is compelling indication that ethylsilane is produced in a free-radical process. Since diethylsilane was formed simultaneously with ethylsilane, and since diethylsilane production was not completely inhibited by the smallest amounts of nitric oxide, a mechanism distinct from the ethylsilane mechanism is thought to be operating for the diethylsilane product. A report of the activity of the SiH_3^+ ion in mass spectral studies of the $SiH_4-C_2H_4$ system demonstrated the occurrence of the ion-molecule reaction $SiH_3^+ + C_2H_4 = SiH_2C_2H_5^+$ with an appreciable rate constant. The foregoing ion-molecule reaction is probably also important in the radiolysis of the silane–ethylene system. That larger amounts of nitric oxide are required for total inhibition of diethylsilane formation is possibly due to the large rate constants for the ion-molecule reactions. (Diss. Abstr. Int., B)

22693 RADICAL AND RADIATION-INDUCED GRAFTING OF SOME SYNTHETIC HIGH POLYMERS WITHIN THE TEMPERATURE RANGE OF THEIR GLASS TRANSITION. Schamberg, Eckehard; Hoigne, Juerg (AG fuer Industrielle Forschung und Strahlennutzung, Zurich). J. Polym. Sci., Part A-1; 8: 693-8(Mar 1970).

The temperature dependence of radioinduced grafting onto poly(ethylene terephthalate), polyamides, polyacrylonitrile, and polypropylene was investigated for several monomers. In all cases a maximum grafting yield is obtained when the reaction is performed in the temperature range of the glass transition T_g of the polymer used. This maximum yield does not only appear with radioinduced simultaneous grafting. It also appears when the graft polymerization is induced by pre-irradiation or even by thermal decomposition of organic peroxides. It is assumed that the pronounced maximum of the reactivity at T_g is obtained because in the glassy state below T_g the radicals formed cannot react due to a reduced diffusion of the monomer, whereas above T_g the number of radicals available for polymerization will be reduced with increasing temperature. (auth)

22694 RADIOCHEMICAL POLYMERIZATION OF ACRYLIC ACID IN LIQUID AND SOLID PHASES. I. Chapiro, A.; Sommerlatte, T. (CNRS, Bellevue, France). Eur. Polym. J.; 5: 707-24(Dec 1969). (In French).

The polymerization kinetics of liquid acrylic acid are complicated by precipitation of the polymer. The conversion curves initially exhibit an auto-accelerating portion, which is followed by an almost straight line. The pseudo-stationary rate is proportional to $I^{0.8}$, and the overall activation energy is 2.7 kcal/mole. The reaction is followed by significant post-polymerization. Irradiation of the crystalline monomer leads to auto-accelerating conversion curves with parabolic shape. The instantaneous rate is proportional to $I^{0.5 \text{ to } 0.6}$; the overall activation energy is 15.1 kcal/mole. A very short postpolymerization was noted. Various additives, such as H_2O, acetic acid, and cyclohexane, increased the polymerization rate at 1°C, whereas benzoquinone and acetone inhibited the reaction. If the monomer was carefully dried prior to irradiation, the rate of polymerization in the crystalline state was strongly reduced. A spontaneous polymerization of acrylic acid was noticed during degassing of very dry monomers. An ESR study conclusively demonstrated that free radicals are trapped in the irradiated crystalline monomer at temperatures where polymerization occurs. (auth)

22695 PRODUCTION OF CARRIER-FREE ^{32}P PHOSPHORIC ACID AND ^{32}P PHOSPHATES. Plejewski, R.; Kucharski, M.; Rybakow, Z. (Inst. of Nuclear Research, Swierk, Poland). Isotopenpraxis; 6: 13-15(Jan 1970).

A routine production process for ^{32}P on a large scale is described. Elementary sulfur is irradiated in the EWA reactor. ^{32}P in the form of orthophosphoric acid is obtained by distillation of sulfur in a vacuum. The process gives yields of about 80 to 100% and the product has sufficiently high chemical and radiochemical purity for medical use. (auth)

22696 RADIATION STABILITY OF AN AROMATIC POLYSULFONE. Brown, J. R.; O'Donnell, J. H. (Univ. of Queensland, Brisbane). J. Polym. Sci.; Part B; 8: 121-6(Feb 1970).

A remarkably high radiation stability of an aromatic polysulfone derived from 2, 2-bis(4-hydroxyphenyl)-propane(bisphenol A) and 4,4'-dichlorodiphenyl sulfone is reported. The polymer was completely soluble in chloroform before and after γ irradiation in air up to the maximum dose employed (500 Mrad) and after doses of up to 250 Mrad in vacuum. However, 500 Mrad in vacuum resulted in an appreciable gel content. The limiting viscosity number decreased from 47.9 to 37.5 $cm^3\ g^{-1}$ after 500 Mrad in air. The total gas yield from the irradiated polysulfone was very low, with G(gas) ≈ 0.1. It consisted mainly of SO_2, H, and H_2O with some CO_2, CH_4, and a C_2 hydrocarbon, apparently propane. (P.C.H.)

22697 RELATION BETWEEN THE STRUCTURE AND THE RADIATION RESISTANCE OF PROTEINS IN THE SOLID PHASE. Van de Vorst, Albert (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 557-85(1969). (In French).

Previous studies on the radiolysis of amino acids, peptides, and proteins are reviewed. Correlation between the radioresistance of these substances and two structural factors, electronic delocalization and molecular dimensions, are discussed in detail. It is apparent that these internal structural factors influence yields from the radiolysis of proteins. (J.G.B.)

22698 EFFECT OF STATE ON SOME RADIOLYSIS PRODUCTS FROM nC_{12} AND nC_{14} FATTY ACID METHYL ESTERS. Macfarlane, J. J.; Sweeting, J. W. (CSIRO Division of Food Preservation, Ryde, New South Wales. Australian Atomic Energy Commission, Lucas Heights, New South Wales). Radiat. Res.; 42: 50-61(Apr 1970).

The yield of most radiolysis products from methyl dodecanoate, indexed to the methyl ester of lauric acid, when γ-irradiated in the solid state, was less than when irradiated in the liquid state. However, the yield of two products, n-dodecane and methyl n-undecanoate, increased on passing from the liquid to the solid state irradiation of the ester. The increase in the yield of n-dodecane was explicable using simple mechanisms of radiolysis. The unsaturated fraction, isolated by using mercury adducts from irradiated liquid methyl tetradecanoate, was found to consist mainly of the positional isomers of methyl tetradecenoate. Examination of the oxidation products from this fraction indicated that all isomers were not present in equal yield. The unsaturated fraction isolated from irradiated solid methyl tetradecanoate was found to contain polyunsaturated components as well as the isomers of methyl tetradecenoate. (auth)

22699 ONE-ELECTRON REACTIONS OF SOME MITOCHONDRIAL COMPONENTS STUDIED BY PULSE RADIOLYSIS. Land, E. J.; Swallow, A. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Biochem. J.; 116: 16P(Feb 1970).

The oxidation and reduction of some components of mitochondria were studied by means of pulse radiolysis. Irradiation of aqueous nicotinamide-adenine dinucleotide $(NAD)^+$ (approx. 0.1 mM) in the presence of formate (0.1M) resulted in the quantitative reaction of the primary products of water radiolysis (H, OH, and e^-_{aq}) to give the semireduced radical NAD°. Conversely, irradiation of NADH in the presence of 0.1M Br^- and N_2O resulted in the oxidation of NADH into the same NAD° radical. Semireduced riboflavin and semireduced ubiquinone may be prepared similarly. Alteration of the pH of the solvent can lead to the identification of the various states of protonation of these radicals. Preliminary pulse radiolysis experiments were also carried out on solutions of cytochrome c. By use of suitable mixtures it was possible to study the movement of single electrons between the different redox components. Thus, in a mixture of NAD^+ (0.2 mM) and riboflavin (0.01 mM) in aqueous formate (0.1 M), the primary products of water radiolysis reacted to give initially NAD°, but the final radical was characteristic of riboflavin, this species being the result of electron transfer from the NAD semiquinone to riboflavin, accompanied by protonation. From the rate of build-up of this riboflavin semiquinone in the presence of a buffer (pH 5.7) electron transfer from NAD° to riboflavin was shown to proceed at the approximately diffusion-controlled rate of 4×10^9 to 5×10^9 l $mol^{-1}\ s^{-1}$. (UK)

22700 STRUCTURE AND REACTIVITY OF THE OXYANIONS OF TRANSITION METALS. PART XVIII. A STUDY OF GAMMA-IRRADIATED POTASSIUM CHROMATE BY ELECTRON SPIN RESONANCE SPECTROSCOPY. Lister, D. H.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 5, 782-5(1970).

Irradiation of K_2CrO_4 at 77°K with γ rays produced two main paramagnetic species that disappeared on warming, though the esr spectra were complicated by spurious lines thought to be from impurities. The first of the two centres is believed to be the electron-deficient species CrO_4^-, and the following esr parameters were obtained for this ion: $g_{xx} = 2.0162$, $g_{yy} = 2.0142$, $g_{zz} = 2.0080$, and $A_x \doteq A_y \doteq A_z \doteq 3G$. A single-crystal study of this ion indicated four magnetically distinct sites in the unit cell for an arbitrary orientation of the external field, with g_{zz} approximately parallel to the c-axis of the crystal. The electron hole is thought to be in a nonbonding orbital on oxygen, hyperfine coupling with the Cr nucleus occurring via spin-polarisation of the Cr–O bonds. The second of the two centres is thought to be CrO_4^{3-}, which gives an esr spectrum that can only be measured below about 10°K. The g-values obtained for this ion are: $g_{xx} = 1.9776$, $g_{yy} = 1.9539$, $g_{zz} = 1.9281$. The reaction sequence leading to the formation of these centres, $CrO_4^{2-} + \gamma \rightarrow CrO_4^- + e^-$; $CrO_4^{2-} + e^- \rightarrow CrO_4^{3-}$, is apparently reversed on warming. (auth) (UK)

22701 THE METASTABLE STATE OF β-CAROTENE EXCITED BY PULSE RADIOLYSIS. Land, E. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Chem. Soc., D; No. 6, 332(1970).

Using pulse radiolysis the lifetime and extinction coefficient of the β-carotene triplet absorption at 515 nm were estimated to be 9 μsec and about $2 \times 10^5\ M^{-1}\ cm^{-1}$. (auth) (UK)

22702 PRINCIPLES OF RADIATION CHEMISTRY. O'Donnell, J. H.; Sangster, D. F. London; Edward Arnold Ltd. (1970). 184p. 45s.

A brief and simple introduction to the subject is given under the following headings: radiation chemistry; interaction of radiation with matter; experimental procedures; special techniques; gaseous systems; aqueous solutions; organic compounds; monomers and polymers; radiation biology and biochemicals; some other systems; and further developments. (UK)

22703 INVESTIGATIONS ON THE THERMAL AND RADIOLYTIC DECOMPOSITION OF ANHYDROUS CRYSTALLINE POTASSIUM CHLORITE. Boyd, G. E.; Brown, L. C. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 74: 1691-4 (16 Apr 1970).

Measurements of the radiolysis at ca. 38°C of anhydrous crystalline $KClO_2$ by ^{60}Co γ rays showed that chlorite ion decomposed in the solid via the overall reaction: $3ClO_2^- \rightsquigarrow Cl^- + 2ClO_3^-$. Radiolytic yields for a dose of 1.0×10^{23} eV/mol $KClO_2$ were: $G(-ClO_2^-) = 33.5 \pm 1.7$; $G(Cl^-) = 10.7 \pm 0.2$; $G(ClO^-) = 0.0$; $G(ClO_3^-) = 22.5 \pm 0.8$; and $G(ClO_4^-) = 0.0$ molecules per 100 eV absorbed. The energy absorbed (3.3 eV/molecule) in the decomposition of ClO_2^- was nearly the same as that required to break a Cl–O bond. The thermal decomposition of $KClO_2$ was strongly exothermic between 135 and 165°C, and the stoichiometry of the reaction was identical with that observed in the radiolysis. A reaction mechanism based on the production of O atoms and their addition to ClO_2^- ions in the crystal lattice is suggested. (auth)

22704 THE EFFECTS OF TEMPERATURE AND ADDITIVES IN THE RADIOLYSIS OF POTASSIUM NITRATE. Pogge, H. Bernhard; Jones, F. T. (Stevens Inst. of Tech., Hoboken, N. J.). J. Phys. Chem.; 74: 1700-5(16 Apr 1970).

The γ radiolysis of KNO_3 was studied as a function of radiation dose and temperature, and with added NO_2^-, ClO_4^-, and $(N^{18}O_3)$ incorporated in the KNO_3 lattice. O_2 and NO_2^- are formed as products by at least two mechanisms, one of which involves O atoms. Both the $KNO_3 \cdot KNO_2$ and $KNO_3 \cdot KClO_4$ systems indicate an O-atom yield of $G_O = 0.45$. O_2 and NO_2^- are also produced by processes not involving O atoms at yields $G_{O_2} = 0.30$ and $G_{NO_2^-} = 1.15$. The isotopic distribution of O_2 formed in $KN^{16}O_3 \cdot KN^{18}O_3$ crystals can be interpreted on the basis of $G_O = 0.50$ and $G_{O_2} = 0.25$. After correcting for thermal decomposition, $G(O_2)$ and $G(NO_2^-)$ in KNO_3 are independent of temperature between 24 and 128°C, but more than double at 128°C and continue to increase with temperature up to the melting point. (auth)

22705 IONIC SPECIES FORMED FROM BENZENE DURING RADIOLYSIS OF ITS SOLUTIONS IN 3-METHYLPENTANE AT 77°K. Ekstrom, A. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 74: 1705-8(16 Apr 1970).

Benzene as a solute in γ-irradiated 3-methylpentane glass at 77°K captures both electrons and positive charge to form anions and cations with distinctive optical absorption spectra. At concentrations below 0.3 mol % these ions appear to be monomeric with absorption maxima at 525 nm and 320 nm, respectively, while above 1 mol % they appear to be dimeric (or polymeric) with absorption maxima at 930 and 1030 nm. (auth)

22706 CHARGE SCAVENGING IN THE RADIOLYSIS AT 20°K OF METHYLCYCLOHEXANE IN THE GLASSY AND CRYSTALLINE STATES. Ekstrom, A.; Willard, J. E. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 74: 1708-11(16 Apr 1970).

The γ radiolysis of polycrystalline methylcyclohexane containing CCl_4, at 20 or 77°K, produces an intense absorption band with a maximum at 425 nm. This is not formed in glassy samples. Competition studies using positive ion scavengers indicate that the species is cationic and that the mobility of positive charge is considerably greater in the crystalline state of methylcyclohexane at 20°K than in the glassy state. (auth)

22707 ABSOLUTE REACTIVITY OF THE OXIDE RADICAL ION WITH METHANOL AND ETHANOL IN WATER. Wander, R.; Gall, Bonnie L.; Dorfman, Leon M. (Ohio State Univ., Columbus). J. Phys. Chem.; 74: 1819-21(16 Apr 1970).

The reactivity of the basic form of the hydroxyl radical, O^-, formed in the radiolysis of water by ionic dissociation of OH ($OH \rightleftharpoons O^- + H^+$) was determined for the reactions with methanol and ethanol. The values obtained for the reaction rate were $(5.8 \pm 0.8) \times 10^8$ and $(11.3 \pm 1.7) \times 10^8$ M^{-1} μsec^{-1} at 25°C for methanol ethanol, respectively. (M.C.G.)

22708 SOME STUDIES ON THE CHEMICAL DAMAGE MECHANISM ALONG CHARGED-PARTICLE TRACKS IN POLYMERS. Boyett, R. H.; Johnson, D. R.; Becker, K. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 42: 1-12 (Apr 1970).

A number of experimental studies were carried out to obtain more information on the chemical damage mechanism along the tracks of charged particles of relatively low LET observed in the more sensitive organic plastics. For example, G-values for free radical production were measured using a radical scavenging technique; infrared spectroscopy and gas chromatography were used for qualitative and quantitative analysis of low molecular weight end products of radiolysis as a function of several parameters, and the stability of latent alpha particle tracks was measured at elevated temperatures. Effects of different agents (influence of oxygen partial pressure and humidity during exposure, and ultraviolet pre- and postirradiation treatment) on the track registration threshold and/or etching kinetics of cellulose nitrate and acetate were also examined. The possible interpretation of the results is discussed. (auth)

22709 RADIATION-INDUCED CONDUCTIVITY AND ION YIELDS IN NEOPENTANE AT HIGH ELECTRIC FIELDS. Schmidt, Werner F. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 42: 73-8(Apr 1970).

The radioinduced conductivity in liquid neopentane, indexed as 2,2-dimethylpropane, was studied at electric field strengths up to 140 kV/cm. The shape of the ionization current vs field strength curve is quite different from that of n-hexane. Extrapolation to infinite field strength gives a total ionization yield of G = 4.03 (W = 24.8) which agrees with the gas-phase value. (auth)

22710 ESR SPECTRA OF IRRADIATED NITROETHANE AND POLYNITROETHYLENE. Tsuji, Kozo; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). Bull. Chem. Soc. Jap.; 43: 572-3(Feb 1970).

Nitroethane and polynitroethylene were irradiated with electron beams, and the ESR spectra were recorded in order to identify the free radicals produced from these compounds. The change in the ESR spectra with an increase in temperature was also examined. The NO_2 radical was clearly visible in the spectra of both compounds. Hyperfine coupling constants and G-values are tabulated. Other free radicals were tentatively identified. (J.G.B.)

22711 THE RADIOLYSIS OF METHANOL AND METHANOLIC SOLUTIONS. VI. CIS AND TRANS-STILBENE. Loeb, Anne M.; Lichtin, N. N. (Boston Univ.). Israel J. Chem.; 7: 799-804(1969).

The use of geometrical isomerization of stilbene as a monitor of radiolytic excitation in methanol solutions was evaluated using gas chromatographic analysis. No evidence for excitation of stilbene was obtained. The mechanistic significance of the observed isomerization of trans-stilbene was obscured by the preponderant simultaneous formation of a variety of other products. The cis-stilbene was much less sensitive to ionizing radiation than its trans-isomer, presumably because of efficient protection by a few percent of 2-methylnaphthalene present as an impurity. (auth)

22712 CURING OF PAINTS AND VARNISHES AS THIN-LAYER POLYMERS BY IONIZING ELECTRON IRRADIATION. Bertrand, A. Rev. Inst. Fr. Petrole Ann. Combust. Liquides; 24: 1151-76(Oct 1969). (In French).

After listing the principal effects of ionizing radiations on organic materials and briefly reviewing their potential industrial applications, the problem of curing paints and varnishes by electron radiation is considered. For this, the process is examined with regard to the following aspects: equipment; coating substances; advantages; economics; and outlets. The conclusion is that this technique is perfectly valid to the extent that, for each type, chemists succeed in determining the proper coating substance to be used from among a great many possible materials. (auth)

22713 STUDY OF THE RADIATION CROSS-LINKING OF RUBBER IN SYNTHETIC LATTICES AND ARTIFICIAL AQUEOUS DISPERSIONS. El'kina, I. A.; Sandomirskii, D. M.; Dogadkin, B. A. (Fine Chemical Tech. Inst., Moscow). Kolloid. Zh.; 32: 124-9(1970). (In Russian).

The radiolysis of synthetic rubber lattices was studied. The rate of radiation cross-linking of polymer in a latex was much greater than in the bulk. The polymer crosslinking efficiency in a latex depends on the polymer hydrocarbon structure and on the colloid-chemical nature of lattices. Stabilizers with a cyclic structure and small globules decrease the crosslinking rate. The radiolysis does not change essentially the colloid-chemical properties of lattices. (auth)

22714 KINETIC STUDIES OF THE PULSE RADIOLYSIS OF TRANS-STILBENE IN SEVERAL SOLVENTS. Ueda, Hisashi (Ohio State Univ., Columbus). Bull. Chem. Soc. Jap.; 43: 297-300(Feb 1970).

The kinetics of the transient species of trans-stilbene in several solvents were studied using a single pulsed electron beam (0.5 $\mu sec \times 300$ mA) and the spectroscopic method. The species existing immediately (0 to 20 μsec) after a pulse is found to disappear according to a sum of two first-order decay-rate equations. The temperature dependence of the formation and decay of this species shows that there are two different trans-stilbene cations, R_s and R_f, which have almost identical absorption spectra but different formation and decay rates. The rate constants for R_s were not affected by the temperature; however, those for R_f were strongly affected. R_f is not found in the solution of trans-stilbene in 1,2-dichloroethane if a small amount of CCl_4 is added. Some effects of the dielectric constant were observed on the decay-rate constant of R_f. From these facts, it can be concluded that R_f is formed by an ordinary transfer of a hole from the solvent cation to the solute molecule. As R_s seems to be formed by a mechanism other than that of R_f, a possible scheme for it is discussed. (auth)

22715 MECHANISM OF HYDROGEN FORMATION IN THE VAPOR PHASE RADIOLYSIS OF METHANOL. Yamamoto, Tatsuo (Tokyo Metropolitan Isotope Research Center). Bull. Chem. Soc. Jap.; 43: 340-4(Feb 1970).

The yields of isotopic hydrogen in the vapor phase radiolysis of deuterated methanol (CH_3OD) were found to be $G(H_2) = 6.1$, $G(HD) = 5.3$, and $G(D_2) = 0.2$. The molecular yields of isotopic hydrogen were also determined by adding propylene as a radical scavenger, $G_M(H_2) = 1.5$, $G_M(HD) = 0.6$, and $G_M(D_2) \sim 0$. In order to estimate the contribution of ionic species for the formation of hydrogen, the ion-molecule reaction of CH_3OD was also investigated by using a mass spectrometer of the differential pumping type. The product ions, such as $(CH_3OCH_2CH_2OD)D^+$ or $(CH_3OD)_2D^+$, which are considered to be formed by the higher order ion-molecule reactions, were observed. The mechanism of hydrogen formation is discussed on the basis of the ionic, the molecular and the radical mechanisms. (auth)

22716 ESR STUDY OF THE OZONIDE ION IN γ-IRRADIATED SODIUM BROMATE. Cosgrove, M. M.; Collins, M. A. (Dept. of Scientific and Industrial Research, Lower Hutt, N. Z.). J. Chem. Phys.; 52: 989-92(15 Jan 1970).

The identification of a paramagnetic center in γ-irradiated sodium bromate crystals as the ozonide ion, O_3^-, is confirmed. At ambient temperatures the principal values of the axially symmetric g tensor were found to be $g_{||} = 2.0035 \pm 0.0001$ and $g_\perp = 2.0220 \pm 0.0001$, whereas at 77°K, $g_{||} = 2.0028 \pm 0.0001$ and $g_\perp = 2.0242 \pm 0.0001$. If the O_3^- ion is a bent molecule of bond angle $116 \pm 5°$ the electron spin resonance data suggest that the O_3^- ion is undergoing rapid motion at ambient temperatures and that the rate of motion is reduced at 77°K. Because no bromine-containing radical is characterized after the ambient temperature irradiation of sodium bromate, the electron spin resonance results suggest a radiolytic decomposition differing from that of the alkaline earth bromates, in which the paramagnetic species BrO_2 is postulated. (auth)

22717 RELEVANCE OF THE CONCENTRATION DEPENDENCE OF METHYL RADICAL FORMATION FROM METHYL BROMIDE SOLUTIONS TO THE DISTRIBUTION OF ION-PAIR SEPARATION DISTANCES IN IRRADIATED HYDROCARBONS. Warman, John M.; Rzad, Stefan J. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 52: 485-90(15 Jan 1970).

A radiochromatographic technique for measuring the yields of

methyl radicals formed on electron capture by methyl bromide in irradiated liquid hydrocarbons is described. $G(CH_3)$ was measured in n-hexane, cyclohexane, and iso-octane from 3×10^{-6} to 0.3M CH_3Br. Below 3×10^{-4}M the yields are described by the equation $G(CH_3) = G_{fi} + K(CH_3Br)^{\frac{1}{2}}$ in agreement with theory. The values of G_{fi} (free-ion yield) determined are 0.12, 0.13, and 0.36 for n-hexane, cyclohexane, and isooctane, respectively. Over the entire concentration range studied, $G(CH_3)$ can be described by the empirical expression $G(CH_3) = G_{fi} + (G_{fi}(\alpha_{CH_3Br}[CH_3Br])^{\frac{1}{2}}/(1 + (\alpha_{CH_3Br}[CH_3Br])^{\frac{1}{2}}))$. A value of approximately 4 is found for the yield of geminately recombining ion pairs for the three hydrocarbons. It is argued from the high-concentration data that the distribution of thermalization distances are closely similar for the different hydrocarbons, in contradiction to the predicted longer distances in iso-octane required to explain the high free-ion yield. (auth)

22718 PRODUCTION OF CARRIER-FREE RADIOISOTOPES FROM TARGETS IRRADIATED WITH DEUTERONS OR α-PARTICLES IN THE U-120 KRAKOW CYCLOTRON. PART 2. PREPARATION OF RADIOISOTOPES OF GADOLINIUM, SAMARIUM, AND THULIUM FROM TARGETS OF SAMARIUM, NEODYMIUM, AND HOLMIUM. Kopta, Stefan; Niewodniczanski, Henryk; Petryna, Tadeusz; Stronski, Ignacy (Inst. of Nuclear Physics, Krakow). Nukleonika; 14: 789-97(1969).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 24216.

22719 EFFECT OF RADIOACTIVE RADIATION ON THE ELECTROCHEMICAL AND CATALYTIC ACTIVITY OF PLATINUM. Pyshnograeva, I. I.; Vasil'ev, Yu. B.; Zimakov, I. E.; Bagotskii, V. S.; Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 189: 1048-51(11 Dec 1969). (In Russian).

Before irradiation the absorption of hydrogen and of oxygen, the evolution of hydrogen and oxygen in 1N H_2SO_4, and also the absorption, dehydrogenation, and electrooxidation of methyl alcohol in 1M CH_3OH + 1N H_2SO_4 were investigated on platinum wire with a diameter of 1 mm and a length of 27 mm (weight = 0.45 g). The wire was then irradiated at a neutron flux of 1.2×10^{13} neutrons/cm^2-sec to give a maximum induced specific activity of 45.5 mCi of ^{197}Pt/g. The absorption of hydrogen fell by greater than a factor of two on platinum with a specific activity of 33.7 mCi/g as compared to the unirradiated platinum. The absorption of hydrogen increases with decreasing specific activity and reaches its initial value at 10 mCi/g which can be considered as a threshold value of the specific activity. Analogous results were observed for the absorption of oxygen. The exchange current and the rate of cathodic hydrogen evolution at a constant overvoltage were almost an order of magnitude higher on an electrode having a specific activity of 30.1 mCi/g than on an inactive electrode. These rate processes depend only on the magnitude of the induced activity and not on the previous history of the platinum cathode. The mechanism of the induced processes is not completely clear. (TTT)

22720 HOT SILICON REACTION WITH SILANES. Cetini, Giuseppe; Castiglioni, Mario; Volpe, Paolo; Gambino, Olimpia (Univ., Turin). Ric. Sci.; 39: 392-4(Apr-Jun 1969).

Reactions of ^{31}Si produced by the reaction $^{30}Si(n,\gamma)^{31}Si$ with silanes were studied. Hot ^{31}Si atoms reacted to cause hydrogen abstraction. Thermalized ^{31}Si scarcely tended to insert into Si–H bonds, but did tend to insert into Si–Si bonds. (M.C.G.)

22721 FORMATION OF CO_2^- RADICAL IONS IN γ-IRRADIATED $NaHC_2O_4 \cdot H_2O$ SINGLE CRYSTALS. Edlund, O. (Swedish Research Councils' Lab., Studsvik, Sweden); Lund, A.; Tellgren, H. pp 293-303 of Magnetic Resonance and Radiofrequency Spectroscopy. Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Co. (1969)

From 15th Ampere Colloquium, Grenoble, France. See CONF-680901.

Single crystals of $NaHC_2O_4 \cdot H_2O$ were irradiated at room temperature and their EPR spectra were recorded at X band for different orientations with respect to the magnetic field. One paramagnetic species, with g = (1.9970, 2.0032, 2.0016) and a ^{13}C splitting A = (151, 156, 196) G with an intensity of about 1/200 of the main absorption was identified as CO_2^-. The directions of the principal axes indicate that the radical retains the orientation of the parent ion. Additional structure was caused by proton hyperfine interaction, as verified by comparison with the deuterated compound. Two couplings were detected. The angular variation of the larger coupling showed that it was largely dipolar with approximately A_H = (1.2, 2.4, –6.1) G. The interactions are probably due to protons hydrogen-bonded to the radical. A likely mechanism for the radical formation is $HC_2O_4^- \rightarrow C_2O_4^- + H \rightarrow CO_2 + CO_2^-$ yielding a radical which, according to neutron-diffraction data, may take part in one strong and two weaker hydrogen bonds. (auth)

Radiochemistry

Refer also to abstract 22666.

Separation Processes

Refer also to abstracts 22623, 22681, 22687, 22908, 22931, 23424, and 23427.

22722 (ANL-Trans-797) SEMI-ANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY, JUNE–NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Sections 2 and 3, pp 82-97; 104-18 of report CEA-N-1148. 15p. Dep. CFSTI.

Abstracts of this paper, prepared from the original language, appeared as NSA 24: 11650 and 24: 11651.

22723 (ANL-Trans-799) SEMI-ANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY, JUNE–NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Section 7, pp 204-22; 248-71 of report CEA-N-1148. 47p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 11653.

22724 (ANL-Trans-800) SEMI-ANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY, JUNE–NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Sections 9.1 and 9.2, pp 298-313; 314-34 of report CEA-N-1148. 36p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 11655.

22725 (ANL-Trans-801) SEMI-ANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY, JUNE–NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Sections 10 and 12.4, pp 336-68; 415-16 of report CEA-N-1148. 39p. Dep. CFSTI.

Abstracts of this paper, prepared from the original language, appeared as NSA 24: 11656 and 24: 11658.

22726 (DOCKET-50332-10) BARNWELL NUCLEAR FUEL PLANT. Addendum No. 4 to Safety Analysis Report. (Allied–Gulf Nuclear Services, Florham Park, N. J.). 28 Apr 1970. 4p. Dep. CFSTI.

Information for addition to the safety analysis report is presented on seismic design. (M.C.G.)

22727 (MLM-1661) FEASIBILITY STUDY FOR LARGE-SCALE SEPARATION OF ^{210}Po FROM BISMUTH METAL BY MOLECULAR DISTILLATION. Chong, C. H. H.; Love, C. M. (Mound Lab., Miamisburg, Ohio). 15 Apr 1970. Contract AT(33-1)-Gen-53. 13p. Dep. CFSTI.

Development studies were conducted to prove the feasibility of distilling polonium from large amounts of irradiated bismuth on a routine production basis. A prototype vacuum distillation system was fabricated for an anticipated 10- to 20-fold enrichment of polonium in one distillation. The experimental hardware also included a decanning system for removing bismuth from its aluminum jacket. Actual experiments with irradiated bismuth were not conducted due to curtailment of the program. Rather, non-irradiated bismuth slugs were employed to determine the necessary parameters required for eventual operation. The mock runs indicated that the concept of molecular distillation for concentrating polonium and the systems developed were valid. (auth)

22728 (NP-18182) THE "CLEAN-UP" PROCESS: A CHEMICAL CHOP PROCESS. Kroebel, R.; Lopez-Menchero, E.; Pivato, J. M. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Dec 1968. 19p. (ETR-243). Dep. CFSTI (U. S. Sales Only).

A new head-end process for zirconium-clad fuel is presented. Essentially, this consists of an electrochemical pretreatment of the oxide-protected zirconium canning, followed by chemical attack, based on the "Zirflex" decanning concept. Such a pretreatment may be carried out either on the whole can surface or on local peripheral bands. The first leads to a faster "Zirflex" decanning operation; the second approach allows local decanning by the "Zirflex" technique, leading to a "Chemical Chop" and this will be followed by a conventional core leaching operation. This second approach has the following advantages: This is the

only method in which the equipment for a chemical-decladding head-end can be used. It increases the head-end capacity because the decanning time is 10 to 12 times shorter than that required for nonpretreated cans and the canning material to be dissolved is about 10 times smaller. It reduces the medium level waste to 15% of the volume obtained when a conventional "Zirflex" decanning process is used. (auth)

22729 (ORNL-4366) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1968. Whatley, M. E.; Haas, P. A.; McNeese, L. E.; Ryon, A. D.; Watson, C. D. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 100p. Dep. CFSTI.

Progress is reported under three headings: engineering separation of macromolecular biological substances, sol-gel development studies, and molten-salt reactor processing studies. An abstract was prepared for each of the three sections. (M.C.G.

For abstracts of individual sections see: 22622, 22730, and 22731.

22730 (ORNL-4366, pp 3-21) ENGINEERING SEPARATION OF MACROMOLECULAR BIOLOGICAL SUBSTANCES. (Oak Ridge National Lab., Tenn.).

The elution operation of the Craig solvent extractor was analyzed mathematically so that its performance can be predicted for the separation of solutes. Gradient effects were studied. (M.C.G.)

22731 (ORNL-4366, pp 41-98) MOLTEN-SALT REACTOR PROCESSING STUDIES. (Oak Ridge National Lab., Tenn.).

Information obtained from the nonradioactive operation of the MSRE Distillation Experiment is summarized. Calculations indicate that distillation of 10 to 40% of MSBR fuel salt will produce a significant increase in the free-fluoride content, which will improve the rare earth: thorium separation factor in the subsequent reductive extraction. A series of experiments to test the feasibility of gas-lift pumping of liquid metals was made with mercury. Measurements of dispersed-phase holdup, continuous-phase pressure drop, and throughput at flooding were made for the countercurrent flow of water and mercury in a 1-in.-diam column containing various types and sizes of packing materials. (auth)

22732 (ORNL-tr-2259) REPROCESSING OF THORIUM-CONTAINING FUELS. Activity Report of the Second Half of 1968, and Summary Report of Section I of the Project. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Translated for Oak Ridge National Lab., Tenn., from German report. 100p. Dep. CFSTI.

The following topics are discussed: chemical disintegration methods for reprocessing graphite-containing fuel elements; fluidized-bed combustion of graphite-containing fuel elements; milling-combustion-leaching process for SiC-coated fuel particles; pyrosulfate-salt melt extraction as a suitable head-end stage; extractive processing of thorium-containing nuclear fuels including adsorptive protactinium separation; and chlorination as an expanded nonaqueous head-end process for graphite-containing fuel elements. Preparative work to date for conducting hot analyses and measuring methods is briefly described. (P.C.H.)

22733 (ORNL-tr-2260) REPROCESSING OF THORIUM-CONTAINING NUCLEAR FUELS. Activity Report of First Half of 1969. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Translated for Oak Ridge National Lab., Tenn., from German report. 79p. Dep. CFSTI.

Developments are reported for studies on: THOREX flowsheet, including combustion of graphite fuel elements in a fixed-bed-fluid bed, combined milling-combustion-leaching process for SiC-coated fuel particles, and adsorptive protactinium separation; KFA-TBP 23/25 flowsheet, including process philosophy, description of the process, and individual process steps; chlorination-extraction process (CHLORINEX-process), including milling and screening, flow properties of finely divided graphite, and chlorination; and hot analysis and radiation instrumentation technology. (P.C.H.)

22734 PROCESS CHEMISTRY. Stevenson, C. E.; Gresky, A. T.; Mason, E. A. Progress in Nuclear Energy, Series III. Volume 4. Oxford; Pergamon Press (1970). 675p. 10 Pound.

This review includes 17 papers for each of which a separate abstract was prepared. Section headings are as follows: papers at the 3rd International Conference on the Peaceful Uses of Atomic Energy; preparation of fuel materials; preparation of fuel solutions for reprocessing; aqueous separation processes; fluoride volatility processing; other nonaqueous fuel processes; and recovery of transuranic and fission product elements. (UK)

For abstracts of individual papers see: 22681 and 22735-22750.

22735 REVIEW OF FUEL PROCESSING TECHNOLOGY PRESENTED AT THE 1964 GENEVA CONFERENCE. Gresky, A. T. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. III; 4: 3-34(1970).

A general summary is presented of the 1964 Geneva Conference papers in the field of reactor fuel processing, together with brief discussions of selected papers on the following topics: ^{233}U separation; hydrogen and heavy water; production of isotopes of other elements; uranium and thorium resources and requirements; prospecting techniques and recovery of uranium from ores; metallic fuels; liquid fuels; ceramic fuels; fuel element fabrication and experience; economics of fuel cycles; safety of chemical processing plants; fuel transport; fuel reprocessing (aqueous processes; fission product and transuranium element recovery); radioactive waste management; and safety aspects of large scale use of atomic energy. (220 references.) (UK)

22736 SOL-GEL TECHNOLOGY IN THE NUCLEAR REACTOR FUEL CYCLE. Ferguson, D. E. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. III; 4: 37-78(1970).

A brief description is given of the principles and methods of "sol-gel" technology, followed by discussions on the following: fundamental properties of thoria (preparation of colloidal thoria by steam denitration of thorium nitrate; chemical properties of colloidal thoria; gelation of thoria sols; sintering behavior of thoria gel); thoria sol-gel process steps (steam denitration of thorium nitrate; dispersion of thoria from the denitrator; gelatin; gelation by extraction of water and microsphere preparation; firing gel to dense ThO_2-UO_2; properties of the fixed product; gases evolved from oxide products on heating in vacuum); process demonstration (preparation of feed materials; thoria preparation; ^{233}U purification; facility description; sizing and vibratory compaction; facility performance; recycle of process material; product characteristics; batch reproducibility; rod fabrication reproducibility; radiation exposure data); other applications of the sol-gel process. (66 references.) (UK)

22737 ELECTROLYTIC DISSOLUTION OF POWER REACTOR FUEL ELEMENTS. Caracciolo, V. P.; Owen, J. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Progr. Nucl. Energy, Ser. III; 4: 81-119(1970).

Electrolytic dissolution of reactor fuel elements in nitric acid permits solvent extraction by conventional processes in stainless steel equipment, and normally resistant metals will dissolve or disintegrate anodically in nitric acid at practical rates. An account is given of the successful dissolution of many types of power fuels on a production scale at several U. S. and British plants. The material to be dissolved can be connected directly to the electrical supply as the anode; stainless steel anodes dissolve in nitric acid at about 0.6g per ampere-hour, which at a current density of 1 A/cm^2 is equivalent to a penetration rate of 30 mils/hr. Two basic electrolytic design principles were investigated for the dissolution of fuel elements in nitric acid. In the first, electrical contact with the dissolving fuel is established through solution (the "liquid contact" principle). In the second, metal-to-metal contact is made with the fuel by means of an electrolytic value-metal basket that serves as both anode and container for the fuel. The "liquid contact" arrangement gives more uniform dissolution rates. Problems associated with corrosion of dissolvers by dissolved stainless steel, limiting current density, cathodic gas evolution, and corrosion of electrode materials are discussed. Dissolution of sintered UO_2 pellets is reported. An account is given of the development of prototype electrolytic dissolvers at the Savannah River Laboratory, including operation and typical operating results for stainless steel-clad fuels, Zircaloy-clad fuels, UO_2-stainless steel cermet fuels, sodium-bonded fuels, and aluminum fuels. An account is also given of the ICPP dissolver design. Also discussed are the effects of fuel characteristics, dissolver loading, temperature, potential, electrolyte composition and sludge formation on performance. (25 references.) (UK)

22738 HEAD-END PROCESSES FOR GRAPHITE-BASE AND CARBIDE REACTOR FUELS. Ferris, L. M. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. III; 4: 121-70(1970).

Typical graphite-base and carbide reactor fuels are described along with problems associated with the head-end procedures that must be carried out before chemical processing proper. The head-end processes are described under the following headings: Graphite-base fuels (burn-leach process, combustion of graphite fuels; fluidized-bed combustion; fixed-bed combustion; combustion of fuels containing particles coated with SiC, BeO, or Al_2O_3; methods tested for lowering the combustion temperature; fission product behavior during combustion; leaching of U, Th, and Pu from combustion residues; dissolving ash from fixed bed combustion; grind-leach process, general flowsheet; coated particle

fuels; crushing and grinding; leaching of crushed unirradiated fuel; studies with irradiated fuel; fuels not containing coated particles; soluble organic compounds in leach solutions; pressurized aqueous combustion; chemical disintegration followed by leaching, 90% HNO_3 process; bromine disintegration and swelling; disintegration with interhalogens; electrodisintegration; combustion-volatility process, combustion-fluorination processes; combustion-chlorination processes; pyrochemical processes) and carbide fuels (reactions of U, Th, and Pu carbides with aqueous reagents; processes for stainless steel clad carbide fuels—pyrohydrolysis-dissolution process; direct nitric acid dissolution process; other possible processes; processes for SAP clad carbide fuels—caustic decladding process; HCl decladding process; other possible processes). (131 references.) (UK)

22739 AQUEOUS PROCESSING OF HIGHLY ENRICHED, ZIRCONIUM BASED, NUCLEAR REACTOR FUELS. Bower, J. R.; Rohde, K. L. (Idaho Nuclear Corp., Idaho Falls). Progr. Nucl. Energy, Ser. III; 4: 171-211(1970).

The aqueous HF process is the principal method used for recovering highly enriched uranium from Zr- or Zircaloy-based fuels in which Zr is the major constituent of the fuel element. A review of this process is presented, together with an account of development work on alternative or supplementary aqueous processes, under the following headings: synopsis of ICPP process (dissolution in Monel equipment); aqueous HF process flowsheet as used at the ICPP; basic dissolution studies related to the aqueous HF process (kinetics of dissolution of Zircaloy-2 in HF–ZrF_4 solutions; continuous dissolution behavior; correlation of dissolution rate data; Zr-containing precipitates in the dissolver; influence of uranium on fuel dissolving conditions, use of oxidants to assist uranium dissolution, effect of temperature on uranium dissolution; general observations on uranium solubility behavior, solubility of UF_4 in dissolver product solutions, deposition and dissolution of uranium in the dissolver, relative dissolution rates of fuel cladding and fuel); process solution adjustment and stability; solvent extraction chemistry (uranium distribution coefficients; fission product behavior); influence of B on the ICPP process; possible head-end modifications to the ICPP process (sodium fluozirconate precipitation process; barium fluozirconate precipitation process); calcination of ZrF_4 wastes; corrosion experience with the ICPP process; high HNO_3–HF processes for dissolution of Zr–U fuels in stainless steel dissolvers (a process for dissolving high Zr–low U alloys; process for dissolving low Zr–high U fuels); ammonium fluoride dissolution processes (Zirflex) for Zr–U fuels in stainless steel equipment; miscellaneous additional aqueous dissolution processes for Zr–U fuels (HF process for dissolution of ZrO_2–UO_2 clad in Zircaloy; fluoboric acid dissolution of 2.5% U–Zr alloys; HF–$Al(NO_3)_3$ as a dissolvent for 2.5% U–Zr alloys; use of HF with strong oxidizers as dissolvents for U–Zr metal or oxide fuels). (38 references). (UK)

22740 EXTRACTION PROCESSING OF IRRADIATED FUELS USING TRIBUTYL PHOSPHATE IN CARBON TETRACHLORIDE. Pushlenkov, M. F. (Khlopin Radium Inst., Leningrad). Progr. Nucl. Energy, Ser. III; 4: 215-31(1970).

Test results for a flowsheet in which TBP in CCl_4 is used as extractant are described, and an account is included of some general principles on which the flowsheet is based. Advantages of using CCl_4 as diluent are enumerated. It is stated that a 1.0 to 1.1M TBP solution is considered to be most suitable for complete U and Pu extraction from 2 to 3M HNO_3 feed solutions, and the maximum concentration of fissionable material in the uranium extracts for these conditions is nuclearly safe. The use of 0.2M TBP solutions is practical only for reprocessing of highly enriched fuels containing much diluent material. Decontamination factors for U, Pu, and Np from fission products should be 10 to 100×10^6 and separation of U, Pu, and Np from one another is expected to be of the order of 10^3. A description of the flowsheet is followed by consideration of treatment of backcycling solutions, radiolysis of extractant and corrosion of equipment, equilibrium distribution of important constituents, and the separation of the irradiated extractant into its components for subsequent purification. (9 references.) (UK)

22741 AMINE EXTRACTION IN REPROCESSING. Coleman, C. F. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. III; 4: 233-85(1970).

A review is presented of recent developments and the current status in amine extraction systems as pertinent to their potential use in nuclear fuel reprocessing, including both studies of the extraction systems per se and their adaptation to particular process uses. Proposed chemical flowsheets are cited for a number of processes in and auxiliary to fuel reprocessing. (148 references.) (auth)(UK)

22742 THE SILEX PROCESS: PARTITION CHROMATOGRAPHY ON SILICA GEL IN AN EXTRACTION FLOWSHEET FOR THE SEPARATION OF PLUTONIUM. Hultgren, A. (Atiebolaget Atomenergi, Studsvik, Sweden). Progr. Nucl. Energy, Ser. III; 4: 287-318(1970).

In plants for the reprocessing of irradiated fuel, plutonium is usually coextracted with uranium and separated in an extraction column; a reducing solution countercurrently re-extracts and reduces the plutonium to an inextractable form. The separation can also be carried out in a conditioned silica gel column, where stage heights are lower and the separation may thus be sharper. Furthermore, in an extraction process where plutonium is selectively extracted in the primary extraction stage, e.g., with trilaurylamine, a chromatographic step can compete with conventional extraction techniques for the transfer of plutonium back to the aqueous phase. Development work on such uses of silica gel, with dibutylcarbitol, tributyl phosphate, and trilaurylamine is summarized, and active pilot plant testing of TBP- and TLA-flowsheets containing a silica gel step is described. (30 references.) (auth)(UK)

22743 THE FIRST USE OF ORGANIC AND INORGANIC ION EXCHANGERS FOR SEPARATING PLUTONIUM FROM URANIUM AND THE FISSION PRODUCTS. Boyd, G. E.; Schubert, J. (Oak Ridge National Lab., Tenn. Univ. of Pittsburgh). Progr. Nucl. Energy, Ser. III; 4: 319-43(1970).

Reasons are outlined for the choice of organic strong-acid cation exchangers and their use in deep, columnar beds to separate plutonium from uranium and fission products. Laboratory experiments are described, which led to various flowsheets for an all-ion exchange process utilizing inorganic cation exchangers and weak-base organic anion exchangers. Two of these flowsheets were tested on a multiliter scale before the research and development effort was terminated in late 1944. The average yield of plutonium for ten single-stage ion-exchange column cycles was greater than 97%, and the decontamination factors averaged 65 for β-emitters and 85 for γ-emitters. (43 references.) (auth)(UK)

22744 FLUID-BED FLUORIDE VOLATILITY PROCESSING OF SPENT REACTOR FUEL MATERIALS. Barghusen, J. J.; Jonke, A. A.; Levitz, N. M.; Steindler, M. J.; Vogel, R. C. (Argonne National Lab., Ill.). Progr. Nucl. Energy, Ser. III; 4: 347-98(1970).

A method under development, based on converting U and Pu in spent fuel to volatile hexafluorides, which can readily be separated from associated fuel materials such as cladding and fission products, followed by purification by established techniques, is described. Fluidization techniques are applied for conducting direct chemical conversion of the fuel materials into gaseous compounds. Topics discussed are as follows: Processing of high-enrichment fuels (reprocessing of U alloy fuels; separation of alloying metal; recovery of U as UF_6; behavior of fission products; reprocessing of UO_2–stainless steel cermet fuels; reprocessing of enriched uranium carbide fuels and oxidation of graphite-base fuels; fluorination of oxidized uranium carbide fuels). Processing of ceramic fuels of low enrichment (decladding of UO_2 fuels by oxidation of UO_2; chemical destruction of cladding; preparation of fuel materials for fluorination; conversion to UO_2F_2 and UF_4; pretreatment of carbide fuels; fluorination of uranium compounds by F_2; two-zone oxidation–fluorination of UO_2; fluorination of UF_4; fluorination of UF_4–UO_2F_2 mixtures; selective fluorination of U from Pu using ClF_3, BrF_5, BrF_3, and use of SF_4; behavior of Pu and Np in selective fluorination; behavior of Pu in fluoride volatility processes; chemical and physical properties of PuF_6; preparation of PuF_6 and comparison with UF_6 and NpF_6; fluorination of PuF_4; special fluorination conditions; fluorination of UO_2–PuO_2 mixtures; separation and purification of UF_6 and PuF_6; separation of UF_6 from PuF_6; separation by selective sorption-desorption techniques; behavior of fission products). For low enrichment fuels processes based on the use of interhalogen fluorides appeared to offer several potential advantages over direct fluorination with F_2. It is considered that the fluid bed fluoride volatility process should be an economically attractive alternative to aqueous reprocessing methods. (119 references.) (UK)

22745 NITROFLUOR PROCESS: A NON-AQUEOUS FLUORIDE-VOLATILITY METHOD FOR RECOVERING URANIUM AND PLUTONIUM FROM VARIOUS REACTOR FUELS. Strickland, G.; Horn, F. L. (Brookhaven National Lab., Upton, N. Y.). Progr. Nucl. Energy, Ser. III; 4: 399-425(1970).

This process provides a method of dissolving various reactor fuels by means of one solvent, and recovering the uranium and plutonium by volatility separation techniques. Dissolution of the fuel and cladding is accomplished in anhydrous HF containing a

complexing agent capable of forming nitrosyl ions (NO^+). The nitrogen oxides, N_2O_4 and N_2O_3, and nitrosyl fluoride (NOF) have this capability. Uranium is separated as hexafluoride by treating the complex metal fluorides, isolated by evaporation of the dissolver solution, with liquid BrF_3. Alternatively, the uranium in the fluoride salts can be volatilized with gaseous NOF, or the uranium in solution can be volatilized directly with F_2. Decontamination and final purification of the UF_6 is accomplished by fractional distillation followed by sorption and desorption with NaF. When plutonium is to be recovered the salts are subsequently treated with F_2, and the PuF_6 evolved is purified by distillation and a series of oxidation-reduction steps. The chemistry and reactions of the nonaqueous solvents are described along with methods of preparation and some data on physical properties. Typical solvents are: (a) 25 mole % NO_2–75 mole % HF; (b) $N_2O_3 \cdot 12.5$ HF; and (c) NOF · 3.1 HF. A description of the process steps is followed by a presentation of the results of small-scale dissolution and separation studies made for the following unirradiated fuels: U–Zr alloy, U–Al alloy and UO_2 clad with stainless steel or Zircaloy-2. More than 99.5% of the uranium was routinely separated from the dissolver solids, and up to 99.6% of the plutonium was removed as PuF_6. Kilogram amounts of the three fuels were dissolved in NOF · 3.1 HF using engineering-scale equipment fabricated of Monel alloy 400. Laboratory experience with the solvents containing N_2O_4 and N_2O_3 has shown that Nickel 200 is superior to Monel alloy 400, and the results of fundamental corrosion studies confirm this. Recommendations for further investigation of the process are given. The problems evident at the present stage of development appear to be manageable. (15 references.) (auth)(UK)

22746 THE SALT CYCLE PROCESS. Harmon, K. M.; Jansen, G. (Battelle Memorial Inst., Richland, Wash.). Progr. Nucl. Energy, Ser. III; 4: 429-60(1970).

This process was conceived and developed as one phase of the Plutonium Recycle Program and derives its name from the use of molten chlorides as reaction media. The major steps are mechanical decladding, dissolution of the fuel in an appropriate salt melt, and reclamation of U and Pu as oxides by electrolytic deposition. Reasons for the design and development of the process are given, together with a brief history, followed by a discussion of the process technology as it stood at the conclusion of its demonstration period. Headings are as follows: salt cycle concept; salt cycle chemistry (melt properties; uranium chemistry; plutonium chemistry); salt cycle process technology (pre-dissolution fuel processing; fuel dissolution; electrodeposition of UO_2; electrocodeposition of PuO_2 and UO_2; precipitation of PuO_2); materials development; process demonstration with irradiated oxide (facility description decladding apparatus; salt bath system; off-gas treatment; process demonstration results; oxidation; dissolution; electrolysis; plutonium precipitation studies; product treatment; product evaluation; discussion and process evaluation. Among conclusions reached are that the technical feasibility of the various unit operations was demonstrated with irradiated fuels by integrated operation in a high pilot plant; that the process is capable of producing reactor grade PuO_2–UO_2 solid solutions as well as PuO_2 and UO_2; that recycle of reclaimed irradiated oxides to a reactor has been successfully demonstrated. Problems remaining to be resolved include criticality control in batch operation; more information is also needed on Pu and fission product behavior, and there is a need for techniques for process monitoring and control, melt clean-up, and improved off-gas handling. (29 references.) (UK)

22747 PYROMETALLURGICAL AND PYROCHEMICAL FUEL PROCESSING METHODS. Steunenberg, R. K.; Pierce, R. D.; Burris, L. (Argonne National Lab., Ill.). Progr. Nucl. Energy, Ser. III; 4: 461-504(1970).

Early pyroprocesses were designed for metallic fuels and emphasis was on the use of simple operations in which the fuel remained in the metallic state throughout the process. An example of this approach is the melt-refining process, which is an oxidative slagging procedure being successfully used to reprocess the metallic uranium fuel alloy from EBR II. Subsequently the use of liquid metals and salts as high temperature solvents was investigated as a means of extending the versatility and performance of pyroprocesses, such solvents being capable of handling ceramic as well as metallic fuels. Separations are effected through fractional crystallization from liquid metal solutions, by vaporization, or by selective oxidation–reduction procedures applied chemically or in electrolytic cells. The processes are suitable for high burn-up short-cooled fuels. The processes are also "compact" the nonvolatile fission product wastes are in the form of solidified metal and salt, and gaseous fission products can be collected in a small volume of inert gas. The processes are reviewed under the following headings: current status of pyrochemical processes; process chemistry (decladding; oxide reduction; extraction between liquid metals and salts; equilibrium considerations; liquid metal solvents; molten salt solvent systems; temperature effects; salt-transport separations); process technology (decladding; reduction; Pu–rare earth separation; U–Pu separation; separation of U or Pu from nobler metals; U and Pu recovery-retorting; fuel resynthesis). It was concluded that most of the basic process chemistry has been worked out, and sufficient laboratory data are available to prepare chemical flowsheets and to estimate overall performance. Much of the technological development is concerned with the use of suitable corrosion resistant materials and the development of remote operation. The primary objective is to devise an economical and technically attractive process for fast breeder fuels. (30 references.) (UK)

22748 PROCESSING METHODS FOR THE RECOVERY OF TRANSPLUTONIUM ELEMENTS. Leuze, R. E.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. III; 4: 549-630(1970).

Processes that have actually been used for large-scale separations of the transplutonium elements are described, with primary emphasis on the process chemistry, and with brief descriptions of the process equipment. (198 references.) (auth) (UK)

22749 METHODS OF RECOVERY AND SOME CHEMICAL PROPERTIES OF THE TRANSPLUTONIUM ELEMENTS. Gureev, E. S. (Kurchatov Inst. of Atomic Energy, Moscow). Progr. Nucl. Energy, Ser. III; 4: 631-43(1970).

A number of flowsheets for the recovery of transplutonium elements with high efficiency were developed, and some methods of production and recovery of these elements are discussed, and results given of physical and chemical investigations of the elements with regard to complexing and extraction with organophosphorus compounds. Headings are as follows: facilitates for transplutonium element production (USSR); complex formation by Am^{3+} and Cm^{3+} in aqueous solutions; extraction of Am, Cm, and some rare earth elements by neutral organophosphorus compounds; investigation of the extraction separation of Am and rare earth elements under static and dynamic conditions; possible variants of schemes for the extraction and decontamination of Am. (18 references.) (UK)

22750 LARGE-SCALE RECOVERY AND PURIFICATION OF FISSION PRODUCTS. Beard, S. J. (Atlantic Richfield Hanford Co., Richland, Wash.); Moore, R. L. Progr. Nucl. Energy, Ser. III; 4: 645-67(1970).

A review is presented of the current status and recent history of the technology involved in recovering fission products from atomic waste and purifying them to the high degree required by most projected applications. Ion exchange and solvent extraction processes were developed for most of the fission products of interest, largely superseding the earlier processes. The former processes are highly selective and have the advantages of potentially very high recoveries and purities, coupled with the economy of continuous operation. It is probable that a combination of precipitation, ion exchange, and solvent extraction technologies would be employed in any integrated plant. The many difficulties encountered in the field are discussed. Headings are as follows: isotopes of interest; current production practice (recovery equipment; lead carrier sulphate precipitation; oxalate precipitation of the rare earths; strontium purification by solvent extraction; separation of Ce from Pm; Pm purification by chromatographic ion exchange; Cs recovery by ion exchange; Tc recovery); alternative technology; large scale production plans; isotope futures. (48 references.) (UK)

22751 RAPID ION EXCHANGE SEPARATIONS. CHROMATOGRAPHIC SEPARATION OF TRANSPLUTONIUM ELEMENTS USING HIGH PRESSURE ION EXCHANGE. Campbell, David O. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop.; 9: 95-9(Jan 1970).

The high-pressure ion exchange method, utilizing very finely divided resin, a high pressure drop, and large flow rates, was demonstrated by separating the six transplutonium elements, americium, curium, berkelium, californium, einsteinium, and fermium, using chromatographic elution from Dowex 50-X12 resin with α-hydroxyisobutyric acid (2-methyllactic acid). All the actinides were separated in good yields and purities in times as short as 1 hour. Product yields were generally better than 99% with substantially less than 1% impurity from other actinides. Purity is limited ultimately by tailing of the elution bands at concentrations about one 1000th of their peak concentrations. Berkelium was not separated from europium. The high pressure system is advantageous for processing highly radioactive materials because the high

flow rate permits reduced exposure time, the high pressure controls bubble formation from radiolytic gas, and the improved resolution yields excellent separations. (auth)

22752 RAPID ION EXCHANGE SEPARATIONS. CHROMATOGRAPHIC LANTHANIDE SEPARATIONS USING A HIGH-PRESSURE ION EXCHANGE METHOD. Campbell, David O.; Buxton, Samuel R. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop.; 9: 89-94(Jan 1970).

Applications of a high-pressure ion exchange system were demonstrated by separating adjacent lanthanide elements by chromatographic elution from Dowex 50 resin. The system utilizes very finely divided ion exchange resin in relatively long columns, and a high pressure is necessary to achieve reasonable flow rates. Satisfactory elutions were obtained at high flow rates, up to 29 ml/cm^2/min, resulting in rapid separations, in less than 1 hr on the 100-mg scale. Resin loadings were demonstrated at flow rates up to 50 ml/cm^2/min. The effects of flow rate, resin loading, eluent composition, and temperature were investigated. Good products were obtained, as long as a small percentage of the resin was loaded with lanthanides. Flow rate had relatively little effect on band width and separation. The equipment developed, and the operating procedures defined, are directly applicable to the separation of transcurium elements at the maximum production rate anticipated at ORNL in the near future. (auth)

22753 PROCESS FOR SEPARATING RARE EARTHS. Trombe, Felix; Caro, Paul (to Centre National de la Recherche Scientifique). U. S. Patent 3,492,084. 27 Jan 1970. Priority date 11 Oct 1965, France.

A process for separation of rare earths takes advantage of the differences in solubilities of the carbonates in the presence of dissolved CO_2. A suspension of a mixture of rare earth carbonates in the presence of CO_2 is reacted with an aqueous solution of soluble salts of the same elements. The suspended solid phase becomes more concentrated in those rare earths whose carbonates exhibit the smallest solubilities and the solution in the salts of the elements whose carbonates exhibit the greatest solubilities. The process may be repeated on the solid suspended phase or on a mixture of hydroxides precipitated from the solution phase. (B.L.M.)

22754 METHOD FOR THE CONCENTRATION OF ^{236}U IN ENRICHED URANIUM FUELS AND FOR MORE EFFICIENT UTILIZATION THEREOF. Ransohoff, Jackson Arthur; Wood, Phillip McKenjie (to Neutron Products Inc.). U. S. Patent 3,503,848. 31 Mar 1970. Filed 9 Nov 1964.

A process for concentrating ^{236}U in ^{235}U-containing nuclear reactor fuels and for preparing ^{237}Np comprises irradiating in a nuclear reactor fuel elements containing U fuel highly enriched in ^{235}U to increase the ^{236}U content of the fuel, subjecting the irradiated fuel to further processing to provide a fuel with a higher ratio of ^{236}U to total U fuel atoms, and recycling the fuel so enriched in ^{236}U for further irradiation in a nuclear reactor having a neutron spectrum more epithermal than that provided by a ^{235}U:H ratio of 0.01. Finally the ^{237}Np produced during the latter irradiation and any subsequent irradiations is recovered. (Offic. Gaz.)

22755 UPON THE SEPARATION OF ^{233}U FROM MACRO CONCENTRATIONS OF THORIUM. Souka, N. (Atomic Energy Establishment, Cairo). Isotopenpraxis; 6: 15-17(Jan 1970).

A procedure for the separation of ^{233}U from macro concentrations of thorium is described. The separation is achieved by selective extraction of uranium from nitric acid solutions using TBP as a solvent. Extraction is carried out in a laboratory mixer-settler apparatus. (auth)

22756 ISOTOPIC EQUILIBRIUM AT THE NORMAL HYDROGEN ELECTRODE. Znamirovschi, V. (Univ., Cluj). Isotopenpraxis; 6: 29-31(Jan 1970).

The potential of the normal hydrogen electrode in the case of isotopic H-D substitution was calculated on the basis of isotopic equilibrium for the H_2O-H_3O^+ and H_2O-H_2 systems. A linear dependence of electrode potential on the isotopic concentration for acid on heavy water solutions was obtained. (auth)

22757 SEPARATION FACTORS FOR SEVERAL LANTHANON PAIRS OBTAINED AT 60°C IN THE ION-EXCHANGE SYSTEM INVOLVING EDTA. Hagiwara, Zenzi; Noguchi, Masaru (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap.; 43: 401-5(Feb 1970).

With a view to the accurate determination of the separation factors of adjacent rare earth pairs between the aqueous and resin phases, measurements were carried out at 60°C in the exchange system involving EDTA and Dowex 50W, X-8, 50 to 100 mesh. Under the same experimental conditions as were used for the isolation of the rare earths by ion exchange, the separation factors at 60°C were found to be 3.43 for Nd–Sm, 1.37 for Eu–Gd, 1.84 for Tb–Y, 1.54 for Y–Dy, 2.83 for Tb–Dy, 1.84 for Dy–Ho, and 2.02 for the Ho–Er, and Er–Tm pairs. The observed values are discussed from the viewpoints of both thermodynamics and the real elution of the rare earths by an ion-exchange column. (auth)

22758 THE THIN-LAYER CHROMATOGRAPHIC PROPERTIES OF TRACE METALS. I. SEPARATION OF SOME METALS WITH SPECIAL REFERENCE TO LEAD. Miketukova, V.; Frei, R. W. (Dalhousie Univ., Halifax, Nova Scotia). J. Chromatogr.; 47: 427-34(31 Mar 1970).

The thin-layer chromatographic behavior of a group of metals has been investigated with various solvent systems on cellulose and silica gel plates and sheets (Eastman Chromagram sheets) by the ascending technique. The results were compared to paper chromatographic separation of the same metals. The cations investigated were Co, Ni, Cu, Bi, Pb, Mn, Cd, V(V), and U(VI). Solvent systems included mixtures of acetone–isopropanol–acetic acid–HCl–water in various combinations and proportions. The separation of lead, which has a strong tendency to tail, was carried out successfully with a solvent mixture of methanol–25% HNO_3–water (8:1:1). New spray reagents, 4-(2-thiazolylazo)-resorcinol, 1-(2-thiazolylazo)-2-naphthol, 4-(2-pyridylazo)-resorcinol, and 1-(2-pyridylazo)-2-naphthol, were successfully introduced for the detection of the metals as distinctly colored complexes. Visual detection limits ranged from 0.1 to 0.01 μg per spot. (auth)

22759 CHROMATOGRAPHY OF NATIVE AND γ-IRRADIATED LYSOZYMES ON DENSE GELS. Maksimov, V. I.; Mosin, V. A. (Inst. of Organic Chemistry, Moscow). J. Chromatogr.: 47: 361-8 (31 Mar 1970).

A chromatographic method has been developed for the isolation of the most heavily damaged part (fraction 1) of γ-irradiated lysozyme. This method cuts secondary changes of protein structure occurring after irradiation to a minimum. The chromatography of native and γ-irradiated lysozymes on gels of high density (Sephadex G-25, Bio-Gels P-6 and P-10) was investigated and the characteristics of chromatography established, viz., 2 types of adsorption, relative large capacity of adsorption, concentration dependence for elution volumes, zonal asymmetry, and the existence of the Johnson–Ogston effect. It is suggested that the chromatographic anomalies of lysozymes are due to the osmotic pressure of its solutions which could reach a large value owing to the Donnan effect. Chromatography of irradiated and thermally denatured lysozymes on Sephadex G-75 as compared to that on Sephadex G-25 showed sharp differences. (auth)

22760 SEPARATIONS OF TRACE ELEMENTS FROM SEA WATER, BRINE, AND SODIUM AND MAGNESIUM SALT SOLUTIONS BY CHROMATOGRAPHY ON CHITOSAN. Muzzarelli, Riccardo, A. A.; Raith, Giuseppe; Tubertini, O. (Univ., Bologna). J. Chromatogr.; 47: 414-20(31 Mar 1970).

Chitosan, a chelating polymer, has been used to collect traces of transition elements from salt solutions and seawater by column chromatography. Chitosan can be favorably compared with the chelating resin Chelex®, and it is proposed as a chelating chromatographic support suitable for pollution detection survey and abatement, for waste water purification, and recovery of trace metal ions for analytical purposes. (auth)

22761 THE BEHAVIOUR OF CATION-EXCHANGE THIN LAYERS WITH ALKALINE AND NEUTRAL SALT SOLUTIONS AS ELUENTS. Lepri, L; Desideri, P. G.; Coas, V.; Cozzi, D. (Univ., Florence). J. Chromatogr.; 47: 442-52(31 Mar 1970).

The behavior of weak and strong ion exchangers in the sodium salt form was studied using neutral solutions of uni- and divalent ions and alkaline solutions of univalent ions as eluents. The influence of various parameters (rate of exchange reaction, diffusion rate, swelling capacity, etc.) on the chromatographic behavior of the ions has been investigated. The conditions for the determination of ionic charge and the selectivity coefficients of the exchangers for some univalent and divalent ions are given. (auth)

22762 USE OF DEAE-CELLULOSE IN INORGANIC THIN-LAYER CHROMATOGRAPHY. Kuroda, R.; Yoshikuni, N.; Kawabuchi, K. (Univ. of Chiba, Japan). J. Chromatogr.; 47: 453-63 (31 Mar 1970).

R_F values for 52 metals obtained on DEAE-cellulose (diethylaminoethylcellulose) in binary solvent systems were surveyed to evaluate the use of DEAE-cellulose in inorganic thin-layer chromatography. R_F values were measured as a function of hydrochloric acid concentration in binary solvent systems consisting of hydrochloric acid and an organic solvent (1:20) such as methanol, n-butanol, acetone, tetrahydrofuran, acetic acid, and cyclohexanone. Useful multicomponent separations are presented to demonstrate the use of R_F measurements for predicting separations in these solvent systems. All the solvent systems tested also afford

separations of particular metals when the organic solvent and hydrochloric acid concentrations are specifically selected; thus, As(III) and Ge can be separated from fifty metals specifically as well as from each other. Ion exchange and partition distribution are proposed as the mechanisms controlling the metal behavior on DEAE-cellulose for the methanolic acid system and for the other five solvent systems, respectively. (auth)

22763 THE THIN-LAYER CHROMATOGRAPHIC PROPERTIES OF TRACE METALS. II. SEPARATION OF SOME CATIONS ON COMMERCIALLY PRECOATED SHEETS. Miketukova, V.; Frei, R. W. (Dalhousie Univ., Halifax, Nova Scotia). J. Chromatogr.; 47: 435-41(31 Mar 1970).

The effects of seven solvent systems on the separation of several metals on commercially precoated cellulose and silica gel sheets were investigated. Suggestions are made for the separation of metals such as Ni, Co, Mn, Cu, Bi, Pb, V(V), and U(VI) in the presence of Zn and Fe(III). Silica gel sheets appeared to be very useful for the separation of a number of cations. Detection limits of 0.1 to 0.01 μg per spot were reported. Some of the suggested separation schemes showed good promise for further evaluation by in situ diffuse reflectance spectroscopy. (auth)

22764 REPROCESSING OF SPENT NUCLEAR FUELS BY FLUORIDE VOLATILITY PROCESSES. Schmets, J. J. (Kernforschungszentrum, Karlsruhe, Ger. Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). At. Energy Rev.; 8: 3-126 (Mar 1970).

The increasing burnups reached by nuclear fuels, or expected from them, provide the motive for studying their consequences in the fissile and fertile materials cycle. Changes undergone by fuels are described and their possible effects on conventional or potential reprocessing techniques are outlined. Fuel reprocessing by volatilization in the form of uranium and plutonium hexafluorides can be subdivided into three branches according to the chemical selectivity of the reactants. The absence of a refined plutonium purification technique in this process is considered. Topics covered include: reprocessing evolution; general factors influencing reprocessing; impact of high burnup on reprocessing and fuel cycles; status of aqueous and dry reprocessing with respect to high burnup fuels; aqueous reprocessing; high-temperature processes; fluoride volatility; processing of U–Al and U–Zr fuels by fluid-bed techniques; reprocessing of oxide fuels; decladding techniques considered for various fuels and reprocessing methods; reprocessing by fluorine only; fuel oxidation; fluorination of U_3O_8; behavior of plutonium during the fluorination period; behavior of neptunium; uranium and plutonium hexafluoride collection systems; uranium final decontamination; conversion of UF_6 into UO_2; specific research on absorbents for purification or separation purposes; plutonium separation and decontamination; reagent recycling; other techniques to reprocess ceramic fuels; reprocessing by chlorine fluorides; reprocessing of dioxide fuels by means of bromine pentafluoride; the reaction of U_3O_8 with BrF_5 in fluid beds; plutonium fluorination; separation of uranium hexafluoride by distillation; and behavior of irradiated fuels. (auth)

22765 ADSORPTION OF CESIUM FROM BASIC WATER SOLUTIONS ON NATURAL MAGNETITE. Petkovic, Dorde M.; Milonjic, Slobodan K. Bull. Boris Kidric Inst. Nucl. Sci., Chem.; 20: No. 3, 17-23(May 1969).

Cesium adsorption from basic water solutions on natural magnetite was investigated. The maximum adsorption of cesium increases with pH of the solutions, and decreases with temperature. The equilibrium constants of the adsorption process, for different pH values and different temperatures, were determined. The changes of free energy, enthalpy, and entropy, were calculated. (auth)

22766 Cs^+/H^+ EXCHANGE ON ZIRCONIUM PHOSPHATE AT HIGH TEMPERATURES UP TO 250°C. Ruvarac, Aleksandar. Bull. Boris Kidric Inst. Nucl. Sci., Chem.; 20: No. 5, 33-8(Oct 1969).

The ion exchange of ^{137}Cs on zirconium phosphate as a function of temperature, pressure, and composition of the aqueous phase was studied. An effort was made to determine the effect of pressure on ion exchange at constant temperature and the effect of temperature on cesium adsorption in dependence on the aqueous phase composition. It was found that in the interval from 1 to 80 atmospheres, the effect of pressure on cesium adsorption is negligible. The effect of temperature at constant pressure was investigated as a function of nitric acid concentrations in aqueous solution. The experiments were made at 50, 100, 150, 200, and 250°C. Cesium adsorption decreases with increasing temperature in the temperature region investigated. From these experimental results, equilibrium constants of the Cs^+/H^+ exchange on zirconium phosphate and thermodynamic quantities for these reactions were calculated. (auth)

22767 SEPARATION OF THE PRINCIPAL COMPONENTS IN MONAZITE. Hughes, K. C.; Carswell, D. J. (Univ. of New South Wales, Kensington). Analyst; 95: 302-3(Mar 1970).

An anion exchange technique is described for the isolation of total rare earths, thorium and uranium in monazite without prior removal of phosphate. Results are in good agreement with those obtained by using the method of Chung and Riley (Anal. Chim. Acta 28: 1(1963)). (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 22785, 22823, 22824, 22827, 23089, 23424, and 23543.

22768 (COO–1057-52) STUDY OF NATURAL RADIATION DAMAGE IN MINERALS BY ELECTRON SPIN RESONANCE AND THERMOLUMINESCENCE. Technical Progress Report, March 1, 1969–March 1, 1970. (Kansas Univ., Lawrence. Dept. of Geology). Contract AT(11-1)-1057. 8p. Dep. CFSTI.

The development of an electron spin resonance method for the estimation of the geologic age of natural rock and mineral samples is described. Samples of apatite from granite samples dated by the rubidium-strontium method are now available for calibration of the ESR method. ESR is also being used with thermoluminescence to aid in the evaluation of the effects of high pressure deformation of minerals. Thermoluminescence is being used as a technique for the recognition of strain in crystalline rock. New experiments have been directed toward the determination of the ability of various crystal lattices to store energy under identical conditions of temperature, particle flux, and particle energy. Research continues on the chemical effects of high-energy protons in solid targets and ESR techniques have been helpful in evaluating the results. Results of measurements on ancient sedimentary rock in the Canadian Shield show organic compounds present and the age estimated to be 3.3 to 3.6 billion years, but dating is now to be performed by conventional methods. (J.C.W.)

22769 (NVO–1229-131) RADIOACTIVITY IN WATER: PROJECT RULISON. Nork, William E.; Fenske, Paul R. (Isotopes, Inc., Palo Alto, Calif.). Feb 1970. Contract AT(29-2)-1229. 20p. (PNE-R-22). Dep. CFSTI.

The Project Rulison detonation was wholly contained within the rocks of the Mesaverde Group. Explosion-produced radioactivity was initially distributed non-uniformly in the collapsed chimney and fractured rock surrounding the working point, WP. Redistribution of the explosion-radioactivity will occur as a result of transport of dissolved and/or particulate matter in any existing mobile ground water in Mesaverde Formation rocks or as a consequence of re-entry drilling and testing. Quite possibly, ground water in the Mesaverde Formation is immobile. In this case all radioactivity will reside where it was initially emplaced unless it is artificially removed and will decay eventually to concentrations below standard levels. Any mobile water in the Mesaverde Formation which becomes contaminated with explosion nuclides, and is located below about 7000 feet is expected to move downward or laterally but not upward. Above 7000 feet any contaminated mobile waters are expected to move laterally. Hydrologic data indicate that the rate of movement of contaminated water will be essentially negligible. Very likely the rate of movement will be low enough and chemical-exchange retardation high enough to prevent transport of nuclides in concentrations for any significant distances. (auth)

22770 (NVO–1229-135) RADIOACTIVITY IN WATER: PROJECT MILROW. Essington, E. H.; Fenske, P. R.; Nork, W. E. (Isotopes, Inc., Palo Alto, Calif.). Mar 1970. Contract AT(29-2)-1229. 45p. Dep. CFSTI.

Post-MILROW event conditions at Amchitka relative to explosion-produced radioactivity in water are discussed. Explosion effects which are related to modification of the hydrologic system are formation of a rubble chimney and collapse sink, formation of water spouts on the island and in the ocean during the seismic phase, creation of lineations in the ocean possibly related to fault and fracture systems during the seismic phase, and formation of a long open fracture about 300 meters (1000 feet) from ground zero that acted as a drain for surface water. Two transport models are proposed to predict migration of radionuclides in water. The conservative model assumes that ground-water flow occurs entirely through fractures. The probable model assumes that groundwater flow is through both fractures and interstitial pores. Both models consider formation of a collapse chimney and chimney infill with water. Migration of radionuclides away from a water filled chimney along a short flow path is predicted by the conservative model to result in greater than one CG tritiated water entering the ocean in about 6.4 years after the explosion. Dilution by mixing in the ocean is expected to reduce these waters to well below one CG in less than one day. In the probable model, no explosion-produced tritium in water above one CG is expected to be discharged from the island as ground-water flow. A post-MILROW radioactivity surveillance program has been established for a network of locations on the island and in the ocean near the island. Samples that have been collected and analyzed as of February 13, 1970 show no levels of tritium above background. (auth)

22771 (SC-CR-68-3637) THE DEVELOPMENT OF THEORETICAL EQUATIONS TO DESCRIBE THE FLOW OF A RADIOACTIVE ION IN GROUND WATER. Annual Report, December 1, 1966–November 30, 1967. Grove, David B. (Geological Survey, Washington, D. C. Sandia Labs., Albuquerque, N. Mex.). Oct 1969. Contract AL-66-848. 58p. Dep. CFSTI.

A mathematical modeling study of the flow of trace concentration of ions through a porous media is described. The theoretical work was performed as an aid in evaluating possible hazards resulting from the earth burial of a SNAP device containing radioactive fuel material. (auth)

22772 (SWRHL–82, pp 280-308) RADIOACTIVITY IN THE HYDROLOGIC ENVIRONMENT. Werner, Louis B. (Isotopes Inc., Palo Alto, Calif.).

Certain proposed uses of nuclear explosives for peaceful purposes will introduce radioactive debris into the natural hydrologic environment. Consideration must therefore be given in each situation to the extent and significance to man of resulting radioactively contaminated water. For contained underground detonations, space-time-concentration predictions of radioactive materials in groundwater are dependent on several factors: radionuclide production and initial distribution, radioactive decay, sorption on geologic materials, and dispersion during hydrologic transport. For uncontained (cratering) detonations, other aspects of the hydrologic cycle, particularly rainfall, and watershed characteristics must be considered. Programs sponsored principally by the U. S. Atomic Energy Commission have investigated these factors. Examination of their net effects on radioactivity concentration in water shows that areas, if any, underlain by water exceeding permissible concentrations tend first to increase in size, then decrease, and finally disappear. Hydrologic processes at the surface remove or redistribute radioactive debris deposited on a watershed to other locations. Where sufficient information is available, predictions of location and concentration of radionuclides in natural waters can be made. Any potentially hazardous conditions arising from a particular detonation can then be evaluated. (auth)

22773 (USGS–474-56) SEQUENCE OF SURFACE MOVEMENT AND FRACTURING DURING SINK SUBSIDENCE, NEVADA TEST SITE. Houser, F. N. (Geological Survey, Denver, Colo.). Feb 1970. Contract AT(29-2)-474. 43p. (NTS–219). Dep. CFSTI.

A study was made of the progression of subsidence phenomena over an underground nuclear explosion cavity in east-central Yucca Flat through the use of an oblique aerial motion picture film. The cause and effect relationships during the structural development of four principal zones of the sink (designated outwardly from the center as zones 1 through 4) are indicated by the sequence of surface movement, stress changes, and fracturing. A central, generally circular area (zone 1), which is radially slightly less than one-half the final sink radius, begins downward movement. As its surface becomes dish-shaped and extended, through slight variations in starting times, tensile stress increases in the surface and the area is radially fractured. As a consequence of movement in the central zone, inward and downward movement begins in the adjacent alluvium (zone 2), which moves virtually en masse. This zone is tilted toward zone 1 and is stressed tensionally until separated from the surrounding alluvium by concentric fractures at the zone 2-zone 3 boundary. Surface tension is soon replaced by compression at the inner boundary of zone 2 and throughout zone 1, closing the concentric and radial fractures previously opened. The release of lateral restraint at the inner edge of zone 3 causes concentrically shaped blocks of alluvium to move inward and downward without significant tilting. This is then followed by simple concentric fracturing in zone 4 outside the topographic lip of the now well-formed sink. (auth)

22774 (USGS–474-65) PRELIMINARY REPORT ON THE GEOLOGIC EFFECTS OF THE FAULTLESS EVENT. Central Nevada-16. McKeown, F. A.; Dickey, D. D.; Ellis, W. L. (Geological Survey, Denver, Colo.). Jan 1970. Contract AT(29-2)-474. 21p. Dep. CFSTI.

The Faultless Event, an intermediate-yield nuclear explosion, produced fractures as much as thousands of feet in length, most of which are along preevent lineaments. Vertical displacements on the fractures are as much as about 15 feet and horizontal displacements are as much as 3 feet. The displacements, particularly vertical offsets on fractures that bound a quasi-sink area around ground zero, may have occurred hours after initial fracturing related to the explosion. The quasi-sink is a graben bounded on

the northwest, southeast, and south by faults; the greatest displacement occurred on a fault at the south margin. The northeast margin of the graben appears to be a hinge line zone characterized by small tension fractures. Preliminary study of data from pre- and postevent surveys indicates that definite strain patterns existed along principal fractures as well as within the quasi-sink. High-speed motion picture photographs taken from a helicopter during the event show clearly the development of two principal fractures about 1.1 second after the explosion. (auth)

22775 (USGS-474-68) GEOHYDROLOGY: PROJECT RULISON, GARFIELD COUNTY, COLORADO. Rulison-5. Voegeli, P. T. Sr.; West, S. W. (Geological Survey, Denver, Colo.). Mar 1970. Contract AT(29-2)-474. 52p. (PNE-R-24). Dep. CFSTI.

Includes section on Aquifer Response by E. H. Cordes.

The Project Rulison nuclear experiment of 40^{+2}_{-4} kilotons yield was detonated at a depth of 8,425 feet below ground level at the Rulison site in Garfield County, Colorado, September 10, 1969. The experiment was designed to stimulate natural gas production from a gas-bearing formation of low permeability. All zones below a depth of 6,129 feet in the Rulison exploratory hole that yielded any water during drilling, or zones interpreted from geophysical logs as being likely to contain water, were hydraulically tested. The pressures recorded during the drill-stem tests of the different zones indicated negligible or no fluid entry to the hole. No fluid was recovered on any of the swab tests performed during the drill-stem tests. Studies of preshot and postshot hydrologic conditions indicate that the detonation did not significantly or permanently affect wells, springs, streams, shallow aquifers, or reservoirs in or near the Rulison site. (auth)

22776 NUCLEAR GEOPHYSICAL METHODS IN THE PROSPECTING, EXPLORATION, AND DEVELOPMENT OF MINERAL RESOURCES. Evteev, M. G.; Migunov, B. B.; Ferronskii, V. I. Sov. Geol.; No. 5, 156-7(1969). (In Russian).

On October 7 to 12, 1968, an All-Union Scientific Technical Conference was held in Minsk on the production and application of isotopes and sources of nuclear radiation in the domestic economy. Papers and reports given in the section of Nuclear Geophysics, devoted to the main trends in application of nuclear geophysical methods in geological investigations, are reviewed briefly. (Geophys. Abstr.)

22777 GEOPHYSICS BY NEUTRINOS. Marx, G. (Roland Eoetvaes Univ. Budapest). Czech. J. Phys.; 19: 1471-9(1969).

A review of the possibilities for the chemical exploration of the central regions of the Earth is given, making use of the antineutrino flux produced by natural radioactive isotopes. (auth)

22778 BLACK SAND CONCENTRATES. Prasad, E. A. V. (Sri Venkateswara Univ., Tirupati, India). Curr. Sci. (India); 37: 232(1968).

An account of black sand concentrates (BSC) found along the East and West coasts of India is presented. Gradation of grain size and chemical and mineralogical composition as reflected in distribution of radioactivity in different fractions of BSC has been studied by Geiger–Muller Counting System and the results are summarized. It was concluded that the same sample of BSC does not have a uniform value of β-activity but shows, very strikingly, a progressive increase towards finer-sized fractions in grain size. A close correlation between grain size and radioactivity has been established. The geological occurrence of BSC and the origin of the minerals are described. (Indian Sci. Abstr.)

22779 CONCENTRATIONS OF ZIRCONIUM AND HAFNIUM IN SOME IGNEOUS AND METAMORPHIC ROCKS AND MINERALS. Brooks, C. K. (Oxford Univ.). Geochim. Cosmochim. Acta; 34: 411-16(Mar 1970).

The results of some recent determinations of Zr and Hf in representative members of several contrasted differentiated igneous rocks are given, together with a number of analyses of some other geologically significant rock types. Zr was determined by x-ray fluorescence using Mo as an internal standard, while Hf was determined by a neutron activation procedure. The Zr/Hf ratio of most crustal rocks was very close to 37. Some lavas showed significantly higher ratios, as also did some strongly differentiated rocks and certain minerals. (UK)

22780 CLASSIFICATION OF RESERVOIRS USING COMPUTERS AS A VARIANT OF COLLECTIVE INTERPRETATION OF LOGGING DATA. Sherman, G. Kh.; Eydman, I. E. Geol. Nefti Gaza; No. 4, 53-6(1969). (In Russian).

A computer program for classifying reservoirs in collective interpretation of geophysical logging data is described. Each object is described by a combination of logging parameters, consisting of values of apparent resistivity (on gradient sondes of laterolog sounding), thickness of the formation, well diameter, relative value of SP, and relative parameters of radioactivity logs (gamma and neutron-gamma). (Geophys. Abstr.)

22781 TESTING THE AIR PERMEABILITY OF SOILS BY THE RADIUM EMANATION METHOD. Imre, J. (National Inst. for Agricultural Quality Testing, Szeged). Agrokem. Talajtan; 17: 407-24(Dec 1968). (In Hungarian).

A radium emanation method was developed for testing the air permeability of soils of various structures and colloidal properties. The principle of the method is determination of the numerical value of the gas diffusion constant (D) as a physical quantity characteristic of the capillary structure and other colloidal properties of the soil by radiation. The method is quicker, simpler, and demands less work than the usual procedures. It yields estimated data concerning the porosity conditions of the soil in several directions and can be carried out on the site with the soil in its natural undisturbed state. The values of the diffusion constants of the soils tested represent a long scale ranging from the upper limit of more than 200 (starting with the sand soils of coarse texture) or in the surface layer of dry sand soils of 250 to 270 cm^2/hr to strongly salt-affected soils of fine texture of less than 2 cm^2/hr. The temperature differences existing in the deeper layers of the soils have practically no significant influence on the diffusion constant. On the other hand, great importance has to be attached to the moisture content of the soil in measuring the rate of gas diffusion. While at low moisture content values the curve of the diffusion constant declines slowly, with increasing moisture content, the number of pores permitting diffusion gradually decreases and at the same time the values of the diffusion constant recede considerably. (BBB)

22782 MINERALOGICAL X-RAY DETERMINATION ON GRANITE SAMPLES SUBJECTED TO AN UNDERGROUND NUCLEAR EXPLOSION. Faure, Jean (CEA, Paris); Ginglinger, Bernard. Compt. Rend., Ser. D; 270: 749-51(9 Feb 1970). (In French).

Analyses by x-ray powder diagrams on samples of granite subjected to an underground nuclear explosion showed no transformations of the crystal lattices under the effect of the shock wave. They revealed the formation of cristobalite and sanidine under the action of the heat generated in the zone near the detonation point. (auth) (France)

22783 RADIOACTIVITY OF VOLCANIC SAMPLES. Imbo, G.; Civetta, L.; Gasparini, P.; Luongo, G.; Rapolla, A.; Vittozzi, P. Ass. Geofis. Ital., Atti Conv. Annu.; 17: 77-83(Mar 1968). (In Italian).

From 17th Annual Conference of the Italian Geophysical Society, Rome, Italy. See CONF-680332-(Pt.1).

The natural radioisotope contents of volcanic samples from throughout the world were determined and compared. A hypothesis is presented to explain the higher radioisotope contents of volcanics from southern Italy. Two γ-spectra, which were obtained respectively by a NaI(Tl) crystal detector and by a germanium semiconductor detector, for a Vesuvian sample are compared in order to show the better resolution of the second spectrum for a more detailed spectrometry. (auth)

22784 GEOLOGICAL RESULTS OF A QUANTITATIVE ESTIMATION OF BASEMENT ROCK RADIOACTIVITY IN YOUNG PLATFORMS (ON AN EXAMPLE FROM CENTRAL KAZAKHSTAN). Tolstoi, M. I.; Stepchenko, S. B.; Serga, A. Yu. (Kiev State Univ.). Geofiz. Sb., Akad. Nauk Ukr. SSR, Inst. Geofiz.; No. 31, 100-10(1969). (In Russian).

Distribution of radioactive elements and total radioactivity of rocks in a typical area of Central Kazakhstan is considered. A number of standard petrological and geochemical problems are solved by the statistical processing of the data with consideration of geological features of the area. (auth)

Meteorology

Refer also to abstracts 22984 and 23153.

22785 (BNWL-1272) DETAILED TIME-HISTORIES OF CONCENTRATIONS RESULTING FROM PUFF AND SHORT-PERIOD RELEASES OF AN INERT RADIOACTIVE GAS: A VOLUME OF ATMOSPHERIC DIFFUSION DATA. Nickola, P. W.; Ramsdell, J. V. Jr.; Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT-(45-1)-1830. 167p. Dep. CFSTI.

A volume of atmospheric diffusion data of exceptional detail is presented. The concentration measurements were obtained from the release of the radioactive gas krypton-85 as an atmospheric

tracer. Measurements were made simultaneously on a real-time basis at 64 field locations. The sampling array, arranged on sampling arcs at distances of 200 and 800 m from the tracer release point, consisted of 40 Geiger-Müller tubes at elevations of 1.5 m above the surface, with 24 more tubes located on six towers. Tower sampling extended to heights of 21 m. Eight of these inert gaseous tracer releases were in the form of instantaneous bursts or puffs, while the remaining five releases took the form of plume releases of 10 to 20 min duration. Vertical wind and temperature profiles for the periods of tracer transport are given. A description of the field system and field techniques is also included. (auth)

22786 (EUR-4418) RESULTS OF MEASUREMENTS OF AMBIENT RADIOACTIVITY IN THE COUNTRIES OF THE COMMUNITY IN 1968: AIR-PRECIPITATION-WATER. (European Communities, Luxembourg. Commission). 1970. 68p. (In several languages). Dep. CFSTI (U. S. Sales Only). EUR. FB 100,-.

The results are given of the measurements carried out in 1968 by the member States at the environmental radioactivity monitoring stations, together with certain data obtained at Euratom's Joint Research Center, Ispra. Three sections dealing with measurements of radioactivity in the air at ground level, in fallout, and in water are given. Most of these measurements relate to total beta radioactivity. The measurement results for certain specific radionuclides are also given as well as the amount of precipitation observed at fallout sampling stations. Graphs are given to show the pattern followed throughout the year, a comparison being drawn with the development over the years, 1962 to 1967, as well as with the situation in 1968 in the United States and Canada. (auth)

22787 (NIRS-RSD-23) RADIOACTIVITY SURVEY DATA IN JAPAN. Number 23. (National Inst. of Radiological Sciences, Chiba (Japan)). May 1969. 17p. Dep. CFSTI (U. S. Sales Only).

A radiation monitoring program has been operating at 25 stations throughout Japan since May 1963. Results obtained between April 1968 and April 1969 are presented. Monthly results for that period are tabulated for ^{137}Cs and ^{90}Sr contents in rain, dry fallout, and surface waters, and the ^{137}Cs, ^{144}Ce, and ^{90}Sr contents in airborne dust. The results of analyzing soil samples at 19 locations to determine the total surface deposition of fallout during July through December 1969 are given. April 1968 to February 1969 data on ^{137}Cs and ^{90}Sr in potable rainwater at numerous locations are tabulated. (L.C.L.)

22788 (NP-18186) STUDY OF DIFFUSION IN THE TROPOSPHERE WITH NATURAL RADIOACTIVE TRACERS. Adroguer, Bernard (Toulouse Univ. (France)). 1970. 190p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The validity and the domain of application of the gradient diffusion transport theory are considered for the atmospheric diffusion of the natural radioactivity (^{220}Rn, ^{222}Rn, and their daughter products). Numerical models for the distribution of the radioactive gases and of their decay products in the troposphere have been elaborated (infinite plane source, infinite half plane source, plane source of finite extent). The influence of different parameters on the vertical distributions was studied and the experimental results were interpreted with the help of these numerical methods. The eddy diffusivity profiles were calculated while taking into account its variations with altitude. A radon sampling device to be taken aboard an aircraft is presented; some experimental profiles as a function of the altitude were drawn up. Their interpretation from the numerical models and from a meteorological detailed analysis confirms that radon is of interest in order to study atmospheric stability and vertical exchanges, and to characterize an air mass or to define its origin. (auth) (France)

22789 (SC-RR-69-788) OPERATION ROLLER COASTER: NEAR GROUND-LEVEL AIR SAMPLER MEASUREMENTS. Church, H. W.; Luna, R. E.; Milly, S. M. (Sandia Labs., Albuquerque, N. Mex.). Feb 1970. 182p. Dep. CFSTI.

Four field trials were performed to investigate the dispersal of nuclides from accidents involving nuclear weapons. Measurements were made of the time-integrated concentration of the aerosol on arcs as far as 15 km from a simulated accident. A general description is given of the Roller Coaster experiments along with details of the air sampling experiments and the instruments used. Results of the measurements are presented in tables, cross-arc plots, peak exposure versus distance curves, isopleth maps, and areas within isopleth curves for the respirable fraction and the total aerosol airborne from each of the four experiments. General features of the air sampling results are discussed as they relate to sampler error, orographic effects, turbulence scale, wind shear, and areas affected by a weapon accident. (auth)

22790 (SWRHL-82, pp 249-79) ATMOSPHERIC TRANSPORT, DIFFUSION, AND DEPOSITION OF RADIOACTIVITY. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.).

From a meteorological standpoint there are two types of initial sources for atmospheric diffusion from Plowshare applications. One is the continuous point-source plume-a slow, small leak from an underground engineering application. The other is the large cloud produced almost instantaneously from a cratering application. For the purposes of this paper the effluent from neither type has significant fall speed. Both are carried by the prevailing wind, but the statistics of diffusion for each type are different. The use of constant altitude, isobaric and isentropic techniques for predicting the mean path of the effluent is briefly discussed. Limited data are used to assess the accuracy of current trajectory forecast techniques. Diffusion of continuous point-source plumes has been widely studied; only a brief review is given of the techniques used and the variability of their results with wind speed and atmospheric stability. A numerical model is presented for computing the diffusion of the "instantaneously produced" large clouds. This model accounts for vertical and diurnal changes in atmospheric turbulence, wet and dry deposition, and radioactivity decay. Airborne concentrations, cloud size, and deposition on the ground are calculated. Pre- and post-shot calculations of cloud center, ground level concentration of gross radioactivity, and dry and wet deposition of iodine-131 are compared with measurements on Cabriolet and Buggy. (auth)

22791 (UCRL-71878) DIFFUSION AND DEPOSITION OF THE SCHOONER CLOUDS. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Dec 1969. 22p. (CONF-700104-16). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

Schooner was a 31-kt nuclear cratering experiment. Detonation was at 0800 PST on December 8, 1968 at the Nevada Test Site. The resulting cloud had ceased its dynamic growth by about H + 4 min. Two distinct parts, a base surge and a main cloud, were evident. Thereafter, further cloud growth was by diffusion and fallout as the cloud moved downwind. Aircraft sampling of the cloud at H + 12.5 min revealed that the main cloud part contained about 10 times as much radioactivity as the base surge part. Later aircraft data, local fallout field measurements, and airborne particle size data indicate that the H + 12.5-min cloud burdens, primarily the tungsten isotopes, were depleted by a factor of about 2, due to fallout, over the next few hours. The remaining airborne cloud burdens for each cloud were used as input to diffusion calculations. Calculated main cloud center concentrations using observed cloud sizes, cloud burdens, and meteorology agree with measurements to better than a factor of 2 over 1½ days. These postshot calculations and data are about a factor of 3 higher than calculations done preshot. Base surge calculations are consistent with available data to within about a factor of 4, but the data needed to perform as complete an analysis as was done for the main cloud do not exist. Fallout, as distinguished from deposition of nonfalling debris, was important to a distance of about 500 km for the main cloud and to a distance of about 100 km for the base surge. At distances closer to ground zero, diffusion calculations under-predicted ground level concentration and deposition, but an isotopically scaled external gross gamma fallout calculation was within about a factor of 3 of the data. At larger distances downwind for the base surge, ground level exposure rate calculations and deposition for a variety of nuclides agreed to within about a factor of 3 of measurements. (auth)

22792 ISOTOPIC COMPOSITION AS A NATURAL TRACER OF LEAD IN THE ENVIRONMENT. Holtzman, Richard B. (Argonne National Lab., Ill.). Environ. Sci. Technol.; 4: 314-17 (Apr 1970).

The method of variations in isotopic ratios to trace the sources of environmental lead and to determine the respective fractions originating from natural and from artificial causes is discussed. The measurements of ^{210}Pb and stable lead were made on four trees 100 to 120 years old, a hickory, a black oak, and two white oaks. A cross section of each trunk taken about 6 feet above the ground was examined. A 30-year old elm was examined for stable Pb. Results and conclusions were made concerning the concentration of ^{210}Pb in each type of tree. The method could be useful in tracing ultimate sources of Pb in man. If food plants are like wood and discriminate between the 204 and 206 isotopes, and if the 206/204 ratios are significantly higher or lower than in the gross sources (atmosphere and soil), then these could be studied under various conditions. (J.C.W.)

22793 STRATOSPHERIC RADIOACTIVE CLOUD DISCOVERED OVER ROME AFTER EXPERIMENTAL "H" EXPLOSION IN CHINA. Pavesi, B. (CENFAM, Rome). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 145-62(Mar 1968). (In Italian).

From 17th Annual Conference of the Italian Geophysical Society, Rome, Italy. See CONF-680332-(Pt.1).

A radioprobe, provided with a Geiger counter for measurement

of the γ and β radiation with energy above 0.25 MeV, was used to measure the stratospheric radioactive cloud detected over Rome after the June 17, 1967, Chinese H-bomb tests. Preliminary measurements were made to determine the background level. The first increased radioactivity was detected on June 25 between 22 and 24 km altitude. The radioactivity measurements showed that the front of the radioactive cloud moved very rapidly. Its length was about 6 km, base at about 17 km altitude and top over 30 km altitude. No appreciable radiocontamination was observed below the base of the cloud. The zone of maximum contamination was almost geometrically centered in the vertical section of the cloud and was located at about 25 km altitude. Graphic results of the measurements made from June 25 to July 2 are presented. (J.S.R.)

22794 DISTRIBUTION OF RADIOACTIVITY IN THE TROPOSPHERE AND STRATOSPHERE NEAR ROME DURING JULY 29 TO AUGUST 9, 1967. Pavesi, B. (CENFAM, Rome). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 163-71(Mar 1968). (In Italian).

From 17th Annual Conference of the Italian Geophysical Society, Rome, Italy. See CONF-680332-(Pt.1).

Radioprobes for the measurement of the radioactivity revealed the presence of much higher activity levels on July 29, 1967, both in the troposphere and some layers of the stratosphere. The tropospheric activity occurred slightly above 10 km altitude and was about four km thick. Two radioactivity layers were detected in the stratosphere: one between 17 and 20 km altitude and the other between 28 and 30 km. The course of the stratospheric and tropospheric masses was calculated, assuming the Chinese H-bomb explosion of June 17 as the source of the radioactivity. The measurements made on August 9, 1967 showed the existence of three layers of contamination at 7,000, 9,000, and 11,000 m of altitude. The vertical motion of the radioactivity was attributed to the great turbulence of the air. (J.S.R.)

22795 STUDIES OF THE POSSIBILITY OF REMOVAL OF RADON FROM THE ATMOSPHERE. Burke, T. P.; Dalu, G. A.; Dalu, G. (Consiglio Nazionale delle Ricerche, Rome). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 545-52(Mar 1968). (In Italian).

From 17th Annual Conference of the Italian Geophysical Society, Rome, Italy. See CONF-680332-(Pt.2).

Experiments in the past suggested that it seems more probable that the removal of radon from the atmosphere occurs by means of a washout mechanism. To test this, direct measurements were made of the radon concentration in an isolated environment enriched with this gas and in which fog was produced artificially. From these experiments, it has been established that the only process which can account for the eliminating of the radon from the atmosphere is the actual radioactive decay of the element itself. (auth)

22796 INFLUENCE OF NATURAL RADIOACTIVE ATMOSPHERIC DUST ON THE RESIDENCE TIME OF ^{210}Pb IN THE TROPOSPHERE. Vilenskii, V. D. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana; 6: 307-10(Mar 1970). (In Russian).

Deviation of the concentration of radioisotopes in the atmosphere from the equilibrium value has been used as a criterion for calculating the residence time of ^{210}Pb and of natural aerosols in the troposphere. If the ^{226}Ra content reflects the equilibrium concentration of ^{210}Pb, it may be assumed that there is a certain equilibrium concentration also in fallout. In order to determine exactly the ratio of ^{210}Pb bound to atmospheric dust particles and the ^{210}Pb formed by the decay of ^{226}Ra, fallout collected in the Moscow region was analyzed to determine simultaneously the ^{210}Pb and ^{226}Ra concentrations. The latter was obtained by the α-scintillation method from the α activity of ^{226}Ra and its short-lived decay products, and the former by the β emission of ^{210}Pb, after purifying the lead with ion exchange resins. It was found that the portion of ^{226}Ra was not constant; it ranged from 2 to 15%. The ratio of ^{210}Pb : ^{226}Ra also varied within wide limits. It was concluded that practically all of the ^{210}Pb in the layer near the Earth and in the atmospheric fallout originates from atmospheric dust particles and cannot be used to estimate the mean residence time of ^{210}Pb in the troposphere. (TTT)

Mineralogy and Exploration

22797 (JEN-207-SIG/1-6) URANIUM ORE DEPOSITS IN CIUDAD RODRIGO PHYLLITES. POSSIBILITY OF NEW DEPOSITS. Mingarro Martin, E.; Marin Benavente, C. (Junta de Energia Nuclear, Madrid (Spain)). 1969. 38p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The main features of the genesis of uranium deposits of the Fe mine-type are discussed. Pitchblende ore is related with phyllites bearing organic material and with geomorphological level, fossilized by eocene sediments. As a result, new uranium ore deposits are possible under Ciudad Rodrigo tertiary basin, tertiary cover depth being little more than three hundred feet. (auth)

22798 (PEL-193) RARE-EARTH MINERAL DEPOSITS IN THE REPUBLIC OF SOUTH AFRICA. von Backstroem, J. W. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Nov 1969. 32p. Dep. CFSTI (U. S. Sales Only).

Interest in the rare-earth metals has quickened considerably in recent years. This tendency has coincided with the development of improved separation and purification techniques and new industrial applications for these metals. The potential resources and reserves of rare-earth minerals in South Africa are described, and a summary review of their production, prices, and outlook to the end of 1968 is given. (auth)

22799 URANIUM LOCALIZATION ON HYDROXYAPATITE BY ANALYSIS OF FISSION-FRAGMENT TRACKS. Thompson, Robert C. (National Inst. of Health, Bethesda, Md.). Science; 167: 1494-7(13 Mar 1970).

The distribution of enriched uranium in individual hydroxylapatite crystals after an exchange reaction was investigated by means of thermal neutron irradiation followed by electron microscopic analysis of fission fragment tracks in plastic support films. One uranyl ion for every two to three surface calcium ions became associated with the mineral but in a nonuniform distribution that strongly favored crystal end regions. (auth)

Oceanography

22800 A SYSTEM FOR DETECTION OF IONIUM, THORIUM, AND PROTACTINIUM TO DATE DEEP-SEA CORES. Heye, Dietrich (Bundesanstalt fuer Bodenforschung, Hanover). Geochim. Cosmochim. Acta; 34: 389-97(Mar 1970).

A highly sensitive system for detection of small quantities of Ra, Tn, and An by delayed coincidences was developed. These isotopes were continually swept from a solution containing their parents into an α-proportional gas counter. Some deep-sea cores were dated and no loss of Ra by diffusion could be found. (auth)(UK)

22801 RADIOMETRIC AND SPECTROMETRIC ANALYSES OF BOTTOM SEDIMENTS ON BOARD THE SHIP. Morozov, V. I.; Nevesskii, E. N.; Petrusev, S. S.; Fedorovskii, Yu. P. Okeanologiya; 9: 522-7(1969). (In Russian).

The natural radioactivity of bottom sediments from some shelf areas of the Black Sea was measured with low-background radiometric and spectrometric devices. An interrelation between granulometric and material composition of sediments and their total radioactivity was found. Data were obtained on the total radioactivity and the amount of separate isotopes in the near-estuarine zones of some rivers; Kuban, Mzymta, Shakhe, Bryb, as well as in the vicinity of Gelendzhik and Karadag. For the Kuban near-estuarine area, some data are presented showing the predominant westward migration of silty material supplied by the river. (auth)

Seismology

Refer also to abstracts 22726, 22840, 22841, and 24862-24864.

22802 (NVO-1163-157) IDENTIFICATION OF ELASTIC WAVE TYPES ON SEISMOGRAMS FROM UNDERGROUND NUCLEAR EXPLOSIONS. Hays, W. W. (Environmental Research Corp., Alexandria, Va.). 15 Oct 1968. Contract AT(29-2)-1163. 86p. Dep. CFSTI.

Topics related to the problem of identification of elastic waves on seismograms from underground nuclear explosions are described. Some of the important facts of theoretical, experimental, and observational studies of elastic waves are reviewed. The analog computer process which was used to facilitate identification as well as the use of travel time data in the identification process is discussed. Examples of elastic wave identification on seismograms of recent nuclear events are presented. A summary of the results and future directions of study are given. (auth)

22803 (NVO-1163-202) ELASTIC WAVE PROPAGATION IN HETEROGENEOUS MEDIA. Beaudet, Paul R. (Environmental Research Corp., Alexandria, Va.). 16 Jan 1970. Contract AT(29-2)-1163. 46p. Dep. CFSTI.

The wave equation is solved for the ensemble average of particle displacements produced by an explosion. The explosion is assumed to occur in a finite cavity in an infinite heterogeneous medium. The solution is applied to the seismic waves generated by an underground nuclear detonation. Field observations from the under-

ground nuclear test program at the Nevada Test Site are in qualitative agreement with the theory. (auth)

22804 (USGS-474-58) SUMMARY OF SEISMIC ACTIVITY IN THE PAHUTE MESA AREA, NEVADA TEST SITE, DECEMBER 8, 1968–JUNE 30, 1969. Hamilton, R. M.; Smith, B. E.; Hall, J. C.; Healy, J. H. (National Center for Earthquake Research, Menlo Park, Calif.). 1970. Contract AT(29-2)-474. 64p. (NTS-222). CFSTI.

Monitoring of seismic activity in the vicinity of the Nevada Test Site was begun on December 8, 1968. Preliminary results are given to accurately locate earthquakes so that their relation with underground nuclear explosions and geologic structures can be determined. The Benham 1.1 megaton explosion was detonated on Dec. 19, 1968, and initiated a sequence of low-level earthquakes. The low-intermediate (20 to 200 kiloton) Purse Event was detonated on May 7, 1969. The explosion reactivated the Benham seismic zone. The model of seismic velocities used in the earthquake location program was derived from a velocity log obtained in the 4.1 km deep exploration hole Ue20f, a summary of Pahute Mesa seismic characteristics, and a synthesis of the U. S. Geological Survey long distance refraction profiles in the Nevada Test Site region. (J.C.W.)

22805 SEISMIC DESIGN FOR NUCLEAR POWER PLANTS. Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Institute of Technology Press (1970). 496p. $17.50.

Fourteen papers on seismic design for nuclear power plants are presented. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 22806–22816 and 24862–24864.

22806 BASIC CONCEPTS AND IMPORTANT PROBLEMS. Whitman, Robert V. (Massachusetts Inst. of Tech., Cambridge). pp 1-68 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The effects of earthquakes on the safety of present and future nuclear power plants are discussed. Basic seismic concepts such as earthquake magnitude, local intensity, response spectra, etc., are defined. The design criteria necessary for assuring the seismic safety of nuclear power plants are reviewed, and methods for determining the seismic threat due to local conditions at a power reactor site are presented. (L.C.L.)

22807 GEOLOGICAL AND SEISMOLOGICAL FACTORS INFLUENCING THE ASSESSMENT OF A SEISMIC THREAT TO NUCLEAR REACTORS. Linehan, Daniel. pp 69-90 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The effect of earthquakes on the safety of nuclear reactors located east of the Rocky mountains is discussed in terms of geologic factors, history of seismic events, methods for assessing the seismic threat, and the safety requirements particular to reactors. The need for more stations for monitoring seismic events in the Central Plains and Eastern US is stressed. (L.C.L.)

22808 GEOPHYSICS. Aki, Keiiti (Massachusetts Inst. of Tech., Cambridge). pp 91-113 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The dislocation theory of an earthquake source may be used for predicting seismic acceleration spectra. At least eight source parameters are needed for describing an "earthquake dislocation." They are strike direction, dip angle, slip angle, fault length, fault width, amount of dislocation, rupture velocity and rise time (or slip velocity). An example of synthesizing acceleration from these parameters is given using the strong motion records of the Parkfield earthquake of 1966. The most important future problem of engineering seismology is to construct a world map showing the distribution of each of the above parameters. (auth)

22809 DESIGN SEISMIC INPUTS. Cornell, C. Allin (Massachusetts Inst. of Tech., Cambridge). pp 114-38 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

In order for the structural analyst to determine the dynamic forces in a given structure during earthquakes, he must have data on the ground motion and forces acting on the base of the structure. The problem is to integrate available seismological information about the ground motion to be expected at the site during future strong motion earthquakes—together with engineering knowledge about their influence on the dynamic response of structures. Several methods for determining the design seismic input to structural analysis are presented. The variables considered include the magnitude and source of earthquakes and soil conditions. More empirical data on seismic wave propagation in various media should result in more exact seismic input data, and therefore should reduce the cost of nuclear power plants which at present must allow for such uncertainties. (L.C.L.)

22810 SOME OBSERVATIONS ON PROBABILISTIC METHODS IN THE SEISMIC DESIGN OF NUCLEAR POWER PLANTS. Cornell, C. Allin (Massachusetts Inst. of Tech., Cambridge). pp 139-41 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

Probabilistic methods of analysis of seismic risk, of design decision making, of ground motions, and of structural response, are discussed. In seismicity studies a probabilistic risk analysis points out the relative importance of various sources and shows explicitly the sensitivity of the results to individual variations in the parameters of each seismic source. The output, a plot of risk versus intensity, provides the structural designer of a nuclear power plant with a more complete description of the seismic environment of a particular site, and permits a more realistic evaluation of how much increase in the seismic capacity of a nuclear power plant is justified in terms of cost and safety. (L.C.L.)

22811 SEISMIC RISK AND SEISMIC DESIGN DECISIONS. Esteva, Luis (Massachusetts Inst. of Tech., Cambridge. Univ. of Mexico, Mexico City). pp 142-82 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The purpose of earthquake-resistant design is to obtain an optimum balance between the expected safety benefits and the cost of structures built in seismic areas. Methods for making earthquake-resistant design decisions are discussed. It is concluded that: the occurrence of earthquake motions at a site is a stochastic process; in order to establish design intensities at a site, both the seismicity parameters and the consequences of each possible manner of structural behavior must be considered; the distribution of intensities at a site has to be estimated from local statistical data on frequency, magnitudes, and focal coordinates of shocks; and wide margins of uncertainty may characterize the form and the parameters of the stochastic process model used to represent seismicity. The use of Bayesian statistics for dealing with the seismicity parameters and their corresponding consequences is recommended. (L.C.L.)

22812 FUNDAMENTALS OF SOIL AMPLIFICATION. Roesset, J. M. (Massachusetts Inst. of Tech., Cambridge). pp 183-244 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

Theoretical methods for deriving the design response spectra at the top of the soil caused by an earthquake at the bottom of the soil are discussed with emphasis on the effects of soil conditions on ground motions during earthquakes. (L.C.L.)

22813 SOIL-STRUCTURE INTERACTION. Whitman, Robert V. (Massachusetts Inst. of Tech., Cambridge). pp 245-69 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

Deformations within the soil immediately beneath a structure may cause the motion at the base of the structure to be different from ground motions at some distance from the structure. This deformation effect, termed soil–structure interaction, affects both the horizontal and vertical motions of the base of the structure and may introduce rocking of the structure. The key features of the soil–structure interaction problem are analyzed by considering three idealized situations: a rigid structure resting on deformable ground, a deformable structure resting on deformable ground, and a structure embedded within deformable ground. (L.C.L.)

22814 EVALUATION OF SOIL PROPERTIES FOR SITE EVALUATION AND DYNAMIC ANALYSIS OF NUCLEAR PLANTS. Whitman, Robert V. (Massachusetts Inst. of Tech., Cambridge). pp 250-305 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

A method for estimating the deformation of soils under loads caused by earthquakes is presented which is based on simple linear stress-strain laws and the selection of parameters needed for a linear viscoelastic analysis. These parameters are modulus or wave velocity, Poisson's ration, and damping coefficient. The approximation, calculation, and both in-situ and laboratory measurements of these soil parameters are discussed. It is concluded that this analysis method is useful and that, for practical analysis, the accuracy with which soil properties can be evaluated is as

good if not better than the accuracy with which the earthquake input can be known. (L.C.L.)

22815 STRUCTURAL RESPONSE TO SEISMIC INPUT. Biggs, J. M. (Massachusetts Inst. of Tech., Cambridge). pp 306-18 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

A brief review of the theory of structural dynamics with regard to ground motion and some general comments on response calculations for reactor structures and for equipment mounted in the structure are presented. (L.C.L.)

22816 MEASURE OF EARTHQUAKE INTENSITY. Arias, Arturo (Massachusetts Inst. of Tech., Cambridge. Univ. of Chile, Santiago de Chile). pp 438-83 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The basis and limitations of empirical scales which have been used in the past to quantitatively express seismic intensity are discussed. Attempts to overcome the limitations of empirical scales and to establish a measure of intensity based on instrumental records of ground motions are described. Finally, a theoretical relation between earthquake intensity and seismic destructiveness is developed which is based on the independent factors of ground acceleration and the damping characteristics of the affected structures. (L.C.L.)

22817 EARTHQUAKES AND EXPLOSIONS: COMMENT ON MOLNAR ET AL. Thirlaway, H. I. S. (United Kingdom Atomic Energy Authority, Blacknest, Eng.). Nature (London); 225: 1237-8(28 Mar 1970).

Reference is made to Molnar et al. (Nature, 224: 1268(1969)) who made the incorrect statement that the shapes of the surface wave spectra for discriminating between earthquakes and explosions were a matter of hypothesis and not tested. It is stated that the spectral differences were demonstrated about two years previously by the Seismological Research Group of the Atomic Weapons Research Establishment at Blacknest, and the experimental data, which included those from explosions at the American, French and Russian test sites, were published in Seismic Methods for Monitoring Underground Explosions (SIPRI, Stockholm, 1968). While the broader interests of seismologists have been well served by Molnar's instrumental development and techniques in the more restricted field of detecting underground explosions it remains to be seen whether a world-wide network of instruments in near-surface faults will be capable of detecting surface waves from overall distant explosions. (UK)

22818 SAFETY AND SECURITY OF POWER PLANTS: NUCLEAR POWER PLANTS AND EARTHQUAKES. J. Power. Div., Amer. Soc. Civil Eng.; 96: 243-51(Feb 1970).

From Conference on Research Needs in Civil Engineering Aspects of Power, Pullman, Wash. See CONF-680907.

The potential hazard from the uncontrolled release of radioactive material from nuclear power plants under earthquake conditions has resulted in unprecedentedly high standards of safety in the design and construction of nuclear power plants. The present status of these standards is reviewed, and research needs for evaluating the effects of earthquakes on components of nuclear power plants are discussed. (L.C.L.)

22819 MAGNITUDE VERSUS YIELD OF EXPLOSIONS. Evernden, J. F. (Dept. of Defense, Washington, D. C.). J. Geophys. Res.; 75: 1028-32(10 Feb 1970).

Data on the P wave magnitudes and yields for nuclear explosions in alluvium, tuff, hard rock, salt, and materials below the water table, and for several chemical explosions in water were used to plot P magnitude (m) versus yield (Y) curves for explosions in each of these media. The results are compared with m vs. Y curves predicted by Carpenter. Good agreements resulted for water at all yields and for alluvium at yields below 1 kT. There was a marked difference between the predicted and measured m vs. Y curves for granite and tuff. The effects of local or near-regional geologic environment on the amplitude of P signal and methods for compensating for this influence of this variable on magnitude estimates are discussed. (L.C.L.)

22820 DECAY RATE OF P-WAVE AMPLITUDES FROM NUCLEAR EXPLOSIONS AND THE MAGNITUDE RELATIONS IN THE EPICENTRAL DISTANCE RANGE 1° TO 98°. Kaila, K. L. (National Geophysical Research Inst., Hyderabad, India). Bull. Seismol. Soc. Amer.; 60: 447-60(Apr 1970).

Study of the decay rate with epicentral distance of P-wave amplitudes from nuclear explosions in the distance range 1° to 98° has revealed that instead of the continuous amplitude curve of Gutenberg, the amplitudes are most appropriately represented by six discontinuous curves. Corresponding to these six amplitude decay curves, magnitude relations were worked out. The new magnitude relations yield consistent magnitudes for nuclear explosions as well as earthquakes independent of epicentral distance over the entire distance range of 1° to 98°. The magnitude values are however slightly shifted towards the higher side by 0.22 magnitude unit (at $M = 4.5$) as compared to those predicted by the Gutenberg–Richter method. Magnitudes are evaluated for Logan, Blanca and Salmon explosions using the new magnitude relations and they agree fairly well with the published magnitudes for these events determined by other workers using the Gutenberg–Richter method. These amplitude decay curves when compared with the travel-time curves of Carder (1964) do show a reasonable correspondence between the starting points of amplitude curves and the distances where the deeply refracted phases from plausible velocity discontinuities in the mantle start appearing as first arrivals on the surface of the Earth. (auth)

22821 REPLY TO THIRLAWAY. Molnar, P. (Columbia Univ., Palisades, N. Y.); Pomeroy, P. W. Nature (London); 225: 1238(28 Mar 1970).

Reference is made to Thirlaway (Nature 225: 1237-8, 1970), and it is stated that although the figures shown in the SIPRI report suggest spectral differences for explosions and earthquakes, it is not possible to attribute these differences unambiguously to the two kinds of sources since earthquake and explosion data were not shown for the same region. The data of the present author (Nature 224: 1268 (1969)) were obtained for nearly identical source regions and propagation paths, and it can be stated unambiguously that differences in the source spectra for the explosions and earthquakes studied must be attributed largely to differences in the two different types of source time functions and not to differences in focal depth, propagation path, radiation pattern, on source dimensions. The authors remain optimistic that their instruments in near-surface vaults will give good results. (UK)

22822 S-WAVE TRAVEL TIME CURVES IN THE NORTHERNLY AZIMUTH FROM INDIA IN THE DISTANCE RANGE 55° DETERMINED FROM SHALLOW EARTHQUAKE DATA. Kaila, K. L.; Reddy, P. R.; Narain, Hari. Bull. Nat. Geophys. Res. Inst.; 6: 167-88(1968).

Analysis of S-wave travel times recorded in India from 38 shallow earthquakes and 2 nuclear explosions with epicenters in the north in the Himalayas, Tibet, China, and U.S.S.R. was carried out using a new statistical method. The travel times up to 55° distance range can be represented by three straight line segments giving apparent velocities of 4.60 ± 0.01, 6.10 ± 0.04, and 7.63 ± 0.06 kmps, respectively, with changes in slope of travel time curves at 21° and 31°. Travel time curves obtained are consistent with P-travel time curves reported in an earlier paper (Seismol. Soc. America Bull., v. 58, p. 1879, 1968). J-B residuals for S-waves to 20° indicate a higher upper mantle velocity (4.60 kmps) in this region as compared to that used in J-B tables. From 20° to 28° residuals are evenly distributed about the zero residual line, and from 28° to 55° they are mostly positive with excess value of about 12 sec. A least square fit between S and P residuals gave a slope of 1.78. (Geophys. Abstr.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 22769, 22770, 22772–22775, 22782, 22788, 22790, 22791, 22802–22804, 22817, 22819–22822, 23130, 23131, 23141–23146, 23148–23150, 23185, 23196, 23224, 23229, and 23231–23234.

22823 (CEA-CONF-1484) NUMERICAL METHODS AND INDUSTRIAL USES OF NUCLEAR EXPLOSIVES. Moreau, E. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 1970. 8p. (In French). (CONF-700305-1). Dep. CFSTI (U. S. Sales Only).

From Meeting on Technical Aspects of Peaceful Uses of Nuclear Explosives, Vienna, Austria.

Numerical methods were used to determine the sensitivity of the effects of nuclear explosives to various parameters in order to prepare actions capable of increasing the desired effects and reducing the unfavorable effects. The use of numerical methods makes it possible to decrease considerably the number of hypotheses made and to integrate the maximum available data in the problem considered. This is a useful simulation method which permits simultaneous economy in the large-scale experimental tests and identification of the cause-to-effect mechanisms of the parameters throughout the simulation. The uses of these methods in non-stationary multidimensional problems are emphasized. Codes treating mechanical and thermal effects on rocks beyond the ionization range were developed. (J.S.R.)

22824 (CEA-R-3941) UNDERGROUND NUCLEAR EXPLOSIONS: STUDY OF FRACTURED ZONES. Derlich, Serge (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Feb 1970. 32p. (In French). Dep. CFSTI (U. S. Sales Only).

Exploration of the environment after underground nuclear tests in the Sahara shows the existence of several zones damaged by the shock wave. The effects were studied by examining the bore-samples and the boring itself. Seismic measurements showed that changes in velocities occur corresponding to the opening up of natural fractures in the earth. It is possible to distinguish successive zones away from the cavity, e.g., a crushed zone, a fractured zone, an internal damaged zone corresponding to the breaking-up of cores into discs, and an external damaged zone. The methods used for examining these various zones resulted in useful information about the zone characteristics. (auth) (France)

22825 (FOA-4-4367) SOME RESULTS FROM THE THEORY OF INTENSIVE EXPLOSIONS AND STRONG SHOCK WAVES. Ryhming, I. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Aug 1968. 80p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

Solutions to the point-source problem and to the descriptive flow field induced from a strong impact with special account to the influence of the thermal radiation are described. A discussion is given of these problems, the treatment of radiation efficiency in a gas and the contributions to the equation of motion from the radiation field. Numerical solutions of advanced problems of the subject are briefly discussed. (auth) (Sweden)

22826 (NVO-1163-199) OBSERVED SEISMIC DATA, MILROW EVENT. (Environmental Research Corp., Alexandria, Va.). Mar 1970. Contract AT(29-2)-1163. 39p. Dep. CFSTI.

The results are given of the processing of the observed ground motions from the Milrow event. The exact yield of the Milrow event is not known. For the purpose of comparing the observed Milrow ground motions with the ground motions that would be predicted on the basis of data from events detonated at the Nevada Test Site (NTS), the Milrow yield has been assumed to be 1,000 kton. On this basis, the 5% horizontal component Pseudo-Relative Velocity (PSRV) spectra (peak response) calculated from the observed Milrow seismograms were compared with predicted horizontal PSRV spectra for a 1,000 kton event. Similarly, the observed peak particle vector amplitudes as a function of distance were also compared to those predicted for a 1,000 kton event. (auth)

22827 (NVO-1163-TM-15) CAVITY FORMED BY A CONTAINED UNDERGROUND NUCLEAR DETONATION. Orphal, D. L. (Environmental Research Corp., Alexandria, Va.). 16 Feb 1970. Contract AT(29-2)-1163. 76p. Dep. CFSTI.

An equation is derived that directly relates the radius of the cavity formed by an underground nuclear detonation to, among other parameters, several physical properties of the geologic environment of the detonation, These physical properties are the vaporization pressure, adiabatic expansion coefficient, density, Young's modulus, cohesive strength, and angle of internal friction. The values of Young's modulus, cohesive strength and angle of internal friction required are those values characteristic of the geologic environment as altered by the outgoing shock wave from the explosion. Assuming what would appear to be reasonable values for the required physical properties, statistical analyses suggest that the derived equation accurately describes cavity radii for underground nuclear events in five geologic media: alluvium, tuff, granite, salt, and rhyolite. The derived equation may be used to predict the cavity radius for an underground nuclear detonation in a geologic environment in which no previous detonations have occurred if the required physical property data are obtained. (auth)

22828 (PNE-521) CLOSE-IN AIRBLAST FROM THE SCHOONER EVENT. Project SCHOONER. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). 17 Apr 1970. 76p. Dep. CFSTI.

Airblast was measured at eight stations along the ground from surface zero to 15,600 feet. Gas-venting peak overpressure was more than ten times that predicted by cube-root scaling from Cabriolet measurements. Ground-shock-induced peak overpressure was about what would have been predicted by the same method. Gas-venting peak overpressures were equivalent to those from a 0.05 to 0.5-kt free airburst, depending on distance, while gas-venting impulses were equivalent to those of a 2-kt free airburst. Higher gas venting overpressure may be due entirely or in part to the greater moisture in the Schooner medium. Measurements, one successful and one partially successful, were made at high zenith angles relative to surface ground zero. Peak overpressures were 3 and 1.75 times those measured along the ground at comparable distances for the ground-shock-induced and gas-venting peak overpressures, respectively, even though impulses were about equal. (auth)

22829 (PNE-957) ENGINEERING PROPERTIES INVESTIGATIONS OF THE CABRIOLET CRATER. Frandsen, A. D. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Oct 1969. 26p. Dep. CFSTI.

The Project Cabriolet nuclear cratering experiment was detonated in a hard, dry rock on Pahute Mesa at the Nevada Test Site. Bedrock at the site is classified as porphyritic trachyte, a rhyolitic type of extrusive igneous rock. The medium is fractured and vesicular in the upper part, but more dense and less fractured at depth. The preshot in situ density of the material within the true crater is estimated at 137 lb/ft^3. Investigations reported consisted of excavating a single trench along a bearing of N18 °E and determining the engineering properties of the ejecta material. The measured bulk density of the ejecta was 124 lb/ft^3 giving a bulking factor of 1.10. The average block size of the ejecta, as determined by mechanical screening, was approximately 0.12 ft (slightly less than 1½ in.). The maximum uplift of the rupture zone observed in the excavated trench is 14 ft. The true crater radius as inferred from observations in the trench is 210 ft. (auth)

22830 (PNE-G-57) DETERMINING THE EXPLOSION EFFECTS ON THE GASBUGGY RESERVOIR FROM COMPUTER SIMULATION OF THE POSTSHOT GAS PRODUCTION HISTORY. Rogers, Leo A. (El Paso Natural Gas Co., Tex.). [1970]. 27p. (CONF-700101-13). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

Analysis of the gas production data from Gasbuggy to deduce reservoir properties outside the chimney is complicated by the large gas storage volume in the chimney because the gas flow from the surrounding reservoir into the chimney cannot be directly measured. This problem was overcome by developing a chimney volume factor F (M^{2}CF/PSI) based upon analysis of rapid drawdowns during the production tests. The chimney volume factor was in turn used to construct the time history of the required influx of gas into the chimney from the surrounding reservoir. The most probable value of F to describe the chimney is found to be 0.150 M^{2}CF/PSI. Postulated models of the reservoir properties outside the chimney were examined by calculating the pressure distribution and flow of gas through the reservoir with the experimentally observed chimney pressure history applied to the cavity wall. A description of the mathematics in the computer program used to perform the calculations is given. Gas flow for a radial model wherein permeability and porosity were uniform through the gas producing sand outside the chimney was calculated for several values of permeability. Calculations wherein the permeability decreased from the chimney out to the "fracture" radius,

and an increased production height was used near the chimney, matched the data better than the simple radial model. Reasonable fits to the data for the first 150 to 200 days of testing have been obtained with permeability which decreased through the fracture region with a $1/r$ or e^{fr} dependence. After 150 to 200 days, the calculations presented indicate too much gas influx into the chimney and a rate of decrease in pressure at the range of GB-2RS which is too rapid. (auth)

22831 (PNE-R-7) PROJECT RULISON: SITE EVALUATION. PRE-SHOT R-EX WELL TEST DATA. (Austral Oil Co., Inc., Houston, Tex. CER Geonuclear Corp., Las Vegas, Nev.). 20 Oct 1969. Contract AT(26-1)-429. 86p. Dep. CFSTI.

Test data for the exploratory well R-EX of Project Rulison were used to determine whether nuclear stimulation has potential as a commercial completion technique in the low productivity, deep, thick, gas bearing Mesaverde formation. Well history and testing data are given. Well R-EX is in close proximity to the emplacement well. (J.C.W.)

22832 (PNE-R-12) PROJECT RULISON FEASIBILITY STUDY. (Austral Oil Co., Inc., Houston, Tex. CER Geonuclear Corp., Las Vegas, Nev.). Jul 1966. 130p. Dep. CFSTI.

A feasibility study was made on the use of an underground nuclear explosive to stimulate the massive Mesaverde gas sand of the Rulison Field in Garfield County, Colorado (Piceance Basin). Two nuclear explosives would be used, one about 1000 feet above the other and fired simultaneously. Rocks ranging in age from Quaternary to pre-Cambrian are present in the area. The tandem arrangement of the explosives is designed to stimulate an extremely thick zone. Although the configuration of the device, the depths of each element (7,500 feet and 8,500 feet), and the thickness of the zone to be fractured, make the shot experimental, the tremendous gas reserves in place promise unusual commercial potential. (J.C.W.)

22833 (PNE-R-19) PROJECT RULISON: A PRELIMINARY REPORT. Reynolds, Miles Jr. (Austral Oil Co., Inc., Houston, Tex.); Bray, Bruce G.; Mann, Robert L. (CER Geonuclear Corp., Las Vegas, Nev.). [1970]. 32p. (CONF-700101-12). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

Project Rulison was designed to use underground nuclear technology to determine the potential of this technique for commercial development of the deep, thick, lenticular, low permeability, Mesaverde Formation of the Rulison Field in Garfield County, Colorado. Since discovery in 1952, this natural gas reservoir has been tested by nine widely-spaced conventionally completed wells. A method of stimulation, far greater in magnitude and efficiency than conventional hydraulic fracturing, is needed to recover this gas at economic rates. A feasibility study completed in July 1966 indicated that nuclear explosives were a potentially economic method of stimulating recovery of natural gas from the reservoir. The gas-in-place, estimated to be between 90–125 billion cubic feet per 640 acres from earlier wells, was confirmed from information obtained on two conventional wells completed in 1966. The Project Rulison exploratory well, R–EX, was completed in May 1968. Detailed testing of this well provided data on geology, hydrology and reservoir characteristics. The data obtained from the testing have been used to determine the flow capacity of the Mesaverde reservoir. The reservoir characteristics were then used as input data to make predictions of post-shot reservoir performance in the nuclear stimulated well, using a radial, unsteady state gas flow computer model. A nuclear explosive with a design yield of 40 kilotons was emplaced in a $10\frac{3}{4}$ inch hole at a depth of 8426 feet below ground surface and detonated on September 10, 1969. A preliminary appraisal of the data taken at shot time indicated that the explosive behaved as predicted. The explosion was completely contained underground as predicted and no major seismic damage occurred. (auth)

22834 (PNE-R-20) ECONOMICS OF NUCLEAR GAS STIMULATION. Frank, G. W. (Austral Oil Co., Inc., Houston, Tex.); Coffer, H. F.; Luetkehans, G. R. (CER Geonuclear Corp., Las Vegas, Nev.). [1970]. 25p. (CONF-700101-8). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

Nuclear stimulation of the Mesaverde Formation in the Piceance Basin appears to be the only available method that can release the contained gas economically. In the Rulison Field alone estimates show six to eight trillion cubic feet of gas may be made available by nuclear means, and possibly one hundred trillion cubic feet could be released in the Piceance Basin. Several problems remain to be solved before this tremendous gas reserve can be tapped. Among these are: rates of production following nuclear stimulation; costs of nuclear stimulation; radioactivity of the chimney gas; and development of the ideal type of device to carry out the stimulations. Each of these problems is discussed in detail with possible solutions suggested. First and foremost is the rate at which gas can be delivered following nuclear stimulation. Calculations have been made for expected production behavior following a 5-kiloton device and a 40-kiloton device with different permeabilities. These are shown, along with conventional production history. The calculations show that rates of production will be sufficient if costs can be controlled. Costs of nuclear stimulation must be drastically reduced for a commercial process. Project Rulison will cost approximately $3.7 million, excluding lease costs, preliminary tests, and well costs. At such prices, nothing can possibly be commercial; however, these costs can come down in a logical step-wise fashion. Radiation contamination of the gas remains a problem. Three possible solutions to this problem are included. (auth)

22835 (PNE-R-21) THE EFFECTS OF THE RULISON EVENT ON BUILDINGS AND OTHER SURFACE STRUCTURES. Lee, Lloyd A.; Skjei, Roger E. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). 14 Jan 1970. 9p. (CONF-700101-9). Dep. CFSTI.

From Meeting on Engineering with Nuclear Explosives, Las Vegas, Nev.

The effects of the Rulison Event on buildings and other surface structures are evaluated. Damage to chimneys, mainly the loosening of mortar joints, was the main structural effect noted. Predictions on ground motions and structural damage from the explosion are compared with observed data. The results showed that the measured ground motions were quite close to the predicted motions, and damage occurred in the locations and generally to the extent predicted. It was easier to predict damage to structures on a qualitative basis than to predict the actual cost of damage settlements. Studies are continuing to further develop the relation between ground motion, structural properties, and damage. (L.C.L.)

22836 (SWRHL-82, pp 9-20) PLOWSHARE PROGRAM. Hamburger, Richard (Atomic Energy Commission, Washington, D. C.).

The Plowshare Program was established in 1957 as a research and development program to develop peaceful uses for nuclear explosives. During that year, the basic concepts, which have guided the program, were proposed for using nuclear explosives in large excavation projects, conservation and management of natural resources, and scientific research. Research has been conducted primarily by the Lawrence Radiation Laboratory at Livermore, California; however, substantial assistance has been provided by a number of other government agencies and national laboratories. Sufficient knowledge of the phenomenology of underground nuclear explosions and their effects has been developed to permit consideration of industrial use of such explosions. To this end, the first government-industry cooperative nuclear experiment, Project Gasbuggy, was conducted in December 1967. Additional proposals have been received for using nuclear explosives in stimulating natural gas production from reservoirs of varying characteristics: The storage of natural gas, the recovery of copper from a low-grade deposit, and preparing oil shales for in situ retorting. It is believed that several experiments in each of these fields are necessary to develop a proven technology. The timely development of a nuclear excavation technology for use in large-scale excavation projects is a primary program objective and, although additional research and development are needed, substantial progress has been made in several areas. A capability for predicting crater sizes from single and row charges has been successfully demonstrated. The development of low fission nuclear explosives for use in excavation projects has been very successful. It is believed that such projects can be conducted safely. Large nuclear excavation projects, such as harbors and canals, must be closely examined in view of the restraints of the limited Test Ban Treaty. Industry's interest and participation in Plowshare continue to increase and commercial use of nuclear explosives can be expected in the near future. Legislation to permit the AEC to provide nuclear explosive services commercially has been introduced in the Congress. The potential obligations that the U. S. would assume under the Non-Proliferation Treaty, would commit the U. S. to providing nuclear explosive services to non-nuclear weapon countries when the necessary technologies have been developed. A number of countries have expressed considerable interest in a variety of peaceful uses for nuclear explosions. (auth)

22837 (SWRHL-82, pp 21-47) NUCLEAR CRATERING APPLICATIONS. Williamson, M. M. (Atomic Energy Commission, Washington, D. C.).

The development of nuclear excavation technology is based on the premise that the relatively inexpensive energy available from

thermonuclear explosives can be used to simultaneously break and move large quantities of rock and earth economically and safely. The economic and other advantages of using nuclear excavation for large engineering projects are discussed. A brief description of the phenomenology of nuclear excavation is given. Each of the several proposed general applications of nuclear excavation is discussed to include a few specific examples of possible nuclear excavation projects, including nuclear excavation for harbors, canals, terrain transits, aggregate production, mining and water resource development and conservation. (auth)

22838 (SWRHL-82, pp 207-22) RADIOACTIVITY SOURCE TERMS FOR UNDERGROUND ENGINEERING APPLICATION. Tewes, Howard A. (California Univ., Livermore. Lawrence Radiation Lab.).

The constraints on nuclide production are usually very similar in any underground engineering application of nuclear explosives. However, in some applications the end product could be contaminated unless the proper nuclear device is used. This fact can be illustrated from two underground engineering experiments — Gasbuggy and Sloop. In the Gasbuggy experiment, appreciable tritium has been shown to be present in the gas currently being produced. However, in future gas stimulation applications (as distinct from experiments), a minimum production of tritium by the explosive is desirable since product contamination by this nuclide may place severe limitations on the use of the tritiated gas. In Sloop, where production of copper is the goal of the experiment, product contamination would not be caused by tritium but could result from other nuclides: Thus, gas stimulation could require the use of fission explosives while the lower cost per kiloton of thermonuclear explosives could make them attractive for ore-crushing applications. Because of this consideration, radionuclide production calculations must be made for both fission and for thermonuclear explosives in the underground environment. Such activation calculations on materials of construction are performed in a manner similar to that described in another paper, but radionuclide production in the environment must be computed using both fission neutron and 14-MeV neutron sources in order to treat the "source term" problem realistically. In making such computations, parameter studies including the effects of environmental temperature, neutron shielding, and rock types have been carried out. Results indicate the importance of carefully evaluating the radionuclide production for each individual underground engineering application. (auth)

22839 (SWRHL-82, pp 309-33) AIRBLAST FROM PLOWSHARE PROJECTS. Reed, Jack W. (Sandia Labs., Albuquerque, N. Mex.).

The purpose of airblast predictions and monitoring is to guard against strong blast waves being carried by the atmospheric acoustic lens into populated areas where they could cause hazard and damage. Experience and theory, with both high explosives and nuclear tests, burst both underground and in the air, have been developed to allow reasonable confidence in safety predictions. Standard explosion calculations and scaling laws are used to define the source strength to distances where quasi-acoustic propagation physics becomes valid. Underground bursts are attenuated by a factor which depends on scaled burst depth and the burst environment material. For row charges the source strength approaches a line source model with cylindrical blast expansion in directions perpendicular to the row. Atmospheric refraction by strata of different temperatures and winds causes nonuniform blast overpressure patterns to be propagated great distances. Jet stream winds may duct and even focus airblasts with as large as 8× magnifications over standard wave expansion at ranges of 30 to 100 miles. Ozonosphere ducting, by warm temperatures and monsoon winds at 30 miles altitudes, can cause 3× magnification at ranges from 70 to 150 miles. For very large explosives, these atmospheric effects can cause nuisance damage and breakage to windows and plaster walls with a slight associated hazard to inhabitants. Damage claims from explosive tests, accidents, and sonic booms have been analyzed to give damage prediction equations in terms of incident airblast overpressure and exposed population. Overpressures can be calculated from source strength and atmospheric propagation parameters. Measurements in communities surrounding various explosives tests have served to verify prediction procedures and interpret the validity of damage claims. (auth)

22840 (SWRHL-82, pp 334-56) GROUND MOTION PREDICTIONS. Loux, Peter C. (Environmental Research Corp., Alexandria, Va.).

Nuclear generated ground motion is defined and then related to the physical parameters that cause it. Techniques employed for prediction of ground motion peak amplitude, frequency spectra and response spectra are explored, with initial emphasis on the analysis of data collected at the Nevada Test Site (NTS). NTS post-shot measurements are compared with pre-shot predictions. Applicability of these techniques to new areas, for example, Plowshare sites, must be questioned. Fortunately, the Atomic Energy Commission is sponsoring complementary studies to improve prediction capabilities primarily in new locations outside the NTS region. Some of these are discussed in the light of anomalous seismic behavior, and comparisons are given showing theoretical versus experimental results. In conclusion, current ground motion prediction techniques are applied to events off the NTS. Predictions are compared with measurements for the event Faultless and for the Plowshare events, Gasbuggy, Cabriolet, and Buggy I. (auth)

22841 (SWRHL-82, pp 357-90) GROUND MOTION EFFECTS. Blume, J. A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.).

Ground motion caused by natural earthquakes or by nuclear explosion causes buildings and other structures to respond in such manner as possibly to have high unit stresses and to be subject to damage or — in some cases — collapse. Even minor damage may constitute a hazard to persons within or adjacent to buildings. The risk of damage may well be the governing restraint on the uses of nuclear energy for peaceful purposes. Theory is advanced regarding structural-dynamic response but real buildings and structures are complex, highly variable, and often difficult to model realistically. The state of knowledge, the art of damage prediction and safety precautions, and ground motion effects from explosions of underground nuclear devices in the continental United States including events Salmon, Gasbuggy, Boxcar, Faultless and Benham are discussed. (auth)

22842 (SWRHL-82, pp 391-400) PLOWSHARE, POLITICS, AND THE PUBLIC INTEREST (BANQUET ADDRESS). (Joint Committee on Atomic Energy (U. S. Congress)).

The significance to the Plowshare Project of recent political developments such as ratification of the Non-Proliferation Treaty, presidential pronouncements, and Joint Committee on Atomic Energy hearings on the Commercial Plowshare Services Bill is discussed. (L.C.L.)

22843 (SWRHL-82, pp 671-83) INDUSTRY POTENTIAL OF LARGE SCALE USES FOR PEACEFUL NUCLEAR EXPLOSIVES. Russell, Paul L. (Bureau of Mines, Denver, Colo.).

The industrial potential for peaceful uses of nuclear explosions is entering a critical stage of development. Should Project Gasbuggy, an experiment to determine to what extent an underground nuclear explosion can stimulate the production of natural gas from low-permeability formations, prove a technical or economic success, a great step forward will have been made. Should other experiments now being considered in natural gas, oil shale, copper, coal, water resources, underground storage, and others, also demonstrate technical or economic advantage, it is conceivable to expect peaceful nuclear explosions to grow from our current rate of one or two experimental shots per year to hundreds of production explosions per year. This growth rate could be severely restricted or reduced to zero if public safety and environmental control cannot be exercised. (auth)

22844 (SWRHL-82, pp 684-96) APPROACHES TO THE CALCULATION OF LIMITATIONS ON NUCLEAR DETONATIONS FOR PEACEFUL PURPOSES. Whipple, G. Hoyt (Michigan Univ., Ann Arbor. School of Public Health).

The long-term equilibrium levels of tritium, krypton-85 and carbon-14 which are acceptable in the environment have been estimated on the following premises: the three isotopes reach the environment and equilibrate throughout it in periods shorter than their half-lives; nuclear detonations and nuclear power constitute the dominant sources of these isotopes; the doses from these three isotopes add to one another and to the doses from other radioactive isotopes released to the environment; and the United States, by virtue of its population, is entitled to 6% of the world's capacity to accept radioactive wastes. These premises lead to the conclusion that U. S. nuclear detonations are limited by carbon-14 to 60 megatons per year. The corresponding limit for U. S. nuclear power appears to be set by krypton-85 at 100,000 electrical megawatts, although data for carbon-14 production by nuclear power are not available. It is noted that if the equilibration assumed in these estimates does not occur, the limits will in general be lower than those given above. (auth)

22845 (SWRHL-99-r) REPORT OF OFF-SITE SURVEILLANCE FOR PROJECT GASBUGGY, MARCH 1967-JUNE 1968. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Feb 1970. 44p. (PNE-G-61). Dep. CFSTI.

The Southwestern Radiological Health Laboratory (SWRHL) began off-site radiological safety operations for Project Gasbuggy

in June 1967. A census was taken during the following three-months of all people and milk cows within 100 miles of the Gasbuggy site. All mining and tunneling operations within 50 miles were also located. The collection of environmental samples to establish background levels of radioactivity was started in early August 1967, when milk and water samples were collected. Vegetation samples for background information were collected in early December 1967. Milk and water samples were collected following the shot and the drill-back operations to find if radiation levels had increased. A network of thermoluminescent dosimeters was established around the site at an approximate eight-mile radius. The dosimeters were exchanged once during the background period, again a few days prior to the event, and collected following the drill-back operations. The Medical and Veterinary Officer's activities began in mid-October 1967, and continued through the drill-back period. These activities consisted of visiting federal, state, and local officials and remaining on standby to handle emergencies that might arise during the operational period. The operational period, or period of major monitoring activity, began in early December 1967, and lasted until mid-January 1968. No release of radioactivity was detected by monitoring or in the analysis of samples collected following detonation. The report presents the activities, data, and conclusions of surveillance activities during the period March 1, 1967 to June 1, 1968. (auth)(TSS)

22846 (UCRL-72332) TECHNICAL STATUS SUMMARY OF PEACEFUL USES FOR NUCLEAR EXPLOSIVES. Nordyke, Milo D. (California Univ., Livermore. Lawrence Radiation Lab.). Feb 1970. 79p. (CONF-700305-2). Dep. CFSTI.

From Meeting on Technical Aspects of Peaceful Uses of Nuclear Explosives, Vienna, Austria.

A summary of the technical status of peaceful uses of nuclear explosives is presented. Three categories of applications are designated as contained explosions, cratering events, and scientific research applications, such as for neutron and seismic experiments and heavy element production. The explosion effects, specific uses, safety, and economics of contained and excavation explosions are described. It is concluded that: for contained applications, seismic damage is a more serious safety problem than radioactive contamination, the economic desirability of contained explosions has not yet been evaluated, and public reaction to these applications is uncertain; and for cratering events, both seismic and contamination effects are safety limitations, although progress is being made in developing a relatively "clean" explosive. Nuclear excavation is limited to very large engineering projects (harbors, canals, etc.) in previously undeveloped areas. Scientific applications to date have been by-products of nuclear tests for other purposes and will probably remain so due to the expense involved. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 22809, 22811, 22813, 22815, 22926, 22930, 23504, 23900–23902, 23932, 23937, 24026–24030, 24032–24075, 24156, and 24485.

22847 (BNWL-1279, pp 9.1) ATR WATER LOOP OPERATION AND MAINTENANCE. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Operating experience associated with this loop is reviewed. A clean loop corrosion test on 126 Zircaloy coupons was conducted during the life of Core II. Conditions maintained during the test include temperature 500°F, pressure 2000 psig, and flow 70 gpm. (J.R.D.)

22848 (DPSPU-69-30-12-X) REPAIR OF A NUCLEAR REACTOR VESSEL. Maloney, J. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). May 1969. Contract AT(07-2)-1. 3p. (CONF-691009-9). Dep. CFSTI.

From Conference on Reactor Operating Experience, San Juan, Puerto Rico.

Repair of a leak in the Type 304 stainless steel wall of the Savannah River Plant C Reactor is described. The stress corrosion crack was of a size that leaked 300 lb per day of heavy water. The repair work was done through a fuel position at the top of the reactor. (J.R.D.)

22849 (TID-25211) OPERATIONS OF THE MARINE PRODUCTS DEVELOPMENT IRRADIATOR. Annual Report, October 1, 1966–September 30, 1967. Kaylor, J. D.; Murphy, E. J.; Huff, J. B.; Holston, J. A. (Bureau of Commercial Fisheries, Gloucester, Mass. Technological Lab.). Jan 1968. Contract AT(49-11)-1889. 150p. Dep. CFSTI.

Programs aimed at establishing the commercial feasibility of irradiating fishery products to obtain an increased extension in shelf life are reviewed. Assuming that only high quality fresh fish are irradiated, the results showed that: a minimum of one week extension in shelf life for haddock resulted from irradiation; a reduction of 90 to 99% in bacterial numbers was found in irradiated cod and haddock fillets; cooking methods had little effect on the quality of irradiated flounder, haddock, or perch until after 21 days storage at 38°F; and, although the bacterial reduction in irradiated oysters is good, the free liquid which accumulated in irradiated fresh-shucked oysters is above the permissible legal limit. Plans for modifying the present radioactive source are presented, and the cost benefits from on-site loading techniques are discussed. (L.C.L.)

22850 (TRG-Report-1977) DIAMETER MEASURING JIG FOR IRRADIATED FUEL PINS. Robertson, A.; Butler, J. K. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Mar 1970. 9p. Dep. CFSTI (U. S. Sales Only). UK 1s. 9d.

A jig is described which has successfully been used for several years to measure the diameter of D.F.R. experimental fuel pins. An improved version which performs automatically under the control of a cam-operated timer is also described. In both cases the output is in the form of digital display. (auth)

22851 (Y-JA-33(Rev.2)) LEAK TESTING AND REPAIR OF HIGH-EFFICIENCY PARTICULATE AIR FILTER BANKS. DeMonbrun, J. R.; Choat, E. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 12 Mar 1970. Contract W-7405-eng-26. 15p. (CONF-680560-1). Dep. CFSTI.

From 7th National Meeting on Society for Applied Spectroscopy, Chicago, Ill.

The program for handling, installing, and testing high-efficiency particulate air (HEPA) filters is described. Quality assurance testing, inspection and installation, the HEPA filter frame design, in-place efficiency testing, in-place leak testing, and repairs and modifications to stop leaks are discussed. (J.C.W.)

22852 REMOTE ENCAPSULATION TECHNIQUES FOR ^{210}Po FUEL FORMS. Baltisberger, R. J.; Brewer, C. O. (Univ. of North Dakota, Grand Forks). Nucl. Met., Met. Soc. AIME; 14: 234-40(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Forecasted ^{210}Po isotopic heat source requirements are large enough to necessitate the use of remote manipulator equipped facilities. The encapsulation laboratory under construction consists of a line of alpha boxes approximately 60 ft in length and shielded by 2 ft of concrete. The cell area is to be supplied with helium by two separate cryogenic purification systems. The line will have capabilities for loading, tungsten-inert gas (TIG) welding in a polonium contaminated atmosphere, decontamination, leak checking, assaying, and TIG or electron beam welding in uncontaminated boxes. The facility consisted of boxes rather than a single cell, so that surface radioactivity could be controlled and progressively lowered as the sources moved through the line to completion. A prime consideration in the encapsulation of polonium was the method of cooling the sources during the various operations. Techniques were developed for maintaining a surface temperature from 200 to 400°F. (auth)

22853 REMOTE ENCAPSULATION TECHNIQUES FOR ^{238}Pu FUEL FORMS. Coffey, D. L. (Mound Lab., Miamisburg, Ohio). Nucl. Met., Met. Soc. AIME; 14: 241-7(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

A remotely operated facility with thick radiation shielding was completed for fabrication of ^{238}Pu sources above 200 W thermal output without excessive neutron and gamma radiation exposure of the operating personnel. Nine interconnected stainless steel alpha boxes with controlled atmospheres were shielded by water. The individual operations included fuel loading, tungsten-inert gas welding, decontamination, helium leak checking, calorimetry, dimensional gaging, and alpha counting. The equipment required to perform these operations was either automatic or operated by mechanical manipulators extending through the radiation shielding. Water-cooled chill blocks controlled the capsule surface temperature during welding and helium leak checking. (auth)

22854 SUPPORT ARRANGEMENT FOR MOUNTING A UNIT IN A BORE. Charcharos, Anthreas Nicholas (to Nuclear Design and Construction Ltd.). British Patent 1,183,598. 11 Mar 1970. Filed 16 Nov 1967.

The support arrangement described comprises co-operating grooves in the unit to be mounted in the bore and with at least one pair of wedge members being located within one of the grooves. Means for moving the wedge members to locking positions in which they project into the other groove are pro-

vided, the arrangement being such that in their projecting locking positions the wedge members co-act to wedge against the sides of the co-operating grooves so as to prevent relative axial movement between the unit and the bore. The bore is preferably circular and the grooves are in co-operating flanges for the unit and bore, the flange for the unit fitting within the flange for the bore. A number of pairs of wedge members in the form of segments are disposed within one groove. A sealing ring may be provided to seal any space between the flanges. The flange for the unit may be of annular form, and the means for moving the wedge members may comprise one or more jacking screws for each wedge member segment. The arrangement may have application in a gas-cooled nuclear reactor in which boiler units or other mechanical equipment such as coolant circulators and service facility units are mounted in boxes extending through the reactor pressure vessel wall. (UK)

22855 REPROCESSING PLANT AT KARLSRUHE. Eitz, A. W. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Schueller, W. Atomwirt., Atomtech.; 15: 74-6(Feb 1970). (In German).

Plans are discussed for a prototype reprocessing plant for fuel elements at Karlsruhe. Its first purpose is familiarization of the German industry with the problems of such an installation. The second purpose is the gaining of technical and economic experience in the operation of such a plant which will serve for the later design of a large industrial reprocessing plant. The prototype is based on the method of extraction from aqueous solutions. A flow sheet and a floor plan for the installation are depicted. (H.B.G.)

22856 RECENT ADVANCES IN ENGINEERING SCIENCE. VOLUME 4. Proceedings of the Fifth Technical Meeting of the Society of Engineering Science Held at Huntsville, Alabama, October 30–November 1, 1967. Eringen, A. C. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969). 361p. $29.50. (CONF-671091).

Nineteen papers (plus one abstract) are included on such topics as electromagnetic fields, gas dynamics, shock waves, aerodynamics, blunt heat shields, solid mechanics, fatigue of metals, inclusions, n-body problems, guidance, space radiators, and lunar surface mining. Separate abstracts were prepared for the four papers in scope for NSA. (L.M.T.)

For abstracts of individual papers see: 23477, 23851, 23942, and 24895.

22857 METHOD AND APPARATUS FOR ELECTRON BEAM CONTROL. (to Ford Motor Co., Ltd.). British Patent 1,182,920. 4 Mar 1970. Priority date 27 Feb 1968, United States.

A scanning electron irradiation device is described. The electrons are emitted from a hot cathode, scanned by deflection coils, accelerated by an electric field, and focused by a magnetic field so that electron beams emerge essentially parallel. (W.H.K.)

22858 RESEARCH NEEDS IN CIVIL ENGINEERING ASPECTS OF POWER. Proceedings of the American Society of Civil Engineers, September 11–13, 1968, Pullman, Washington. J. Power Div., Amer. Soc. Civil Eng.; 96: 187-276(Feb 1970). (CONF-680907).

Seven papers on research needs in the civil engineering aspects of power generation are presented. Separate abstracts were prepared for 2. Five papers on fuel resources, air pollution, water pollution, pumped storage, and test facilities were not in scope for NSA. (L.C.L.)

For abstracts of individual papers see: 22818 and 22972.

22859 DISPOSAL OF EFFLUENTS FROM DESALINATION PLANTS. Zeitoun, M. A. (Dow Chemical Co., Freeport, Tex.); McIlhenny, W. F.; Reid, R. O. Chem. Eng. Progr., Symp. Ser.; 65: No. 97, 156-66(1969).

An approximate analytical solution of the differential equations governing the flow and density distribution for an upwardly projected dense jet was obtained. Experimental results obtained in a laboratory model established the proportionality of the average height of these jets to the flow conditions and density differences and checked Turner's formula. The distribution of dye concentration across these jets was found to Gaussian, with two distinctly different slopes identifying a middle region of upward flow, surrounded by an outer region of downward flow. The analytical methods are being developed to calculate initial dilution in jets of negative buoyancy to be used in the appropriate design of diffusers for outfall pipelines from desalination plants. (auth)

22860 APPARATUS FOR MILLING AND DRILLING OF GROOVES AND RADIAL HOLES INTO THE INTERNAL WALL OF TUBES. Mahler, Heinz (to European Atomic Energy Community). British Patent 1,189,167. 22 Apr 1970. Priority date 15 Aug 1966, Germany.

An apparatus is described for use in milling or drilling radial holes into the internal walls of tubes. The tube is clamped to a setting rig and a guide member is inserted into the tube to control the follower which locates the area to be milled. A template controls the milling depth. The apparatus is useful in evaluating fuel tubes. (J.R.D.)

22861 PROBLEMS OF THE MATERIALS TO BE IRRADIATED IN IRRADIATION RIGS PROVIDED WITH REACTOR FUEL ELEMENTS. Suckow, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis; 6: 21-6(Jan 1970). (In German).

The polyenergetic spectrum of fuel element gamma radiation variation with time calls for special reflections to reliably determine the dosage to the material being irradiated. Characteristic material parameters have been derived with the aid of which the material to be irradiated can universally be characterized. The effects of material parameter variations on homogeneity and efficiency of the irradiation process are discussed. Moreover, the influence of variable energetic spectrum on the dose distribution in the materials to be irradiated has been investigated for various conditions of fuel element operation. The conditions for optimum material range are derived with the aid of the results obtained. (auth)

22862 RADIATION TREATMENT OF INDUSTRIAL WASTEWATERS: ECONOMIC ANALYSIS. Mytelka, A. I. (AeroChem Research Labs., Inc., Princeton, N. J.). Chem. Eng. Progr., Symp. Ser.; 65: No. 97, 246-50(1969).

The analysis reveals that if radiation induced oxidation pretreatment of industrial waste waters is to become economically feasible, the overall efficiency of the oxidation reactions must be increased by factors ranging from two to twenty-five times those presently obtainable. In order for this large increase in reaction efficiency to take place, a better understanding of the chemistry involved will be necessary. (auth)

22863 HEAT ACTUATED PUMP. Javellaud, Jean; Recule, Albert (to Commissariat a l'Energie Atomique). British Patent 1,187,482. 8 Apr 1970. Priority date 29 Jul 1966, France.

Design of a heat actuated pump for transferring high temperature corrosive fluids under pressure is described. A valve controlled entrance and exit is provided with a cylindrical tank. An electric resistance heater is installed axially along the cylinder which operates intermittently to heat the internal fluid in the casing and force it through the exit valve by expansion. (J.R.D.)

22864 METHOD OF PRODUCING A SEALING-TIGHT JOINT BETWEEN TWO TUBES AND JOINT PRODUCED BY THE METHOD. Bernard, Jean-Andre; Faraoni, Adamo-Renato (to European Atomic Energy Community). British Patent 1,187,893. 15 Apr 1970. Priority date 19 Apr 1967, Belgium.

A method for making a leak-tight end-to-end joint between two tubes made of different materials and having differing wall thicknesses (thick and thin) is described. In this method, the thin tube is formed with a flange or collar around its end. This collar abuts the end face of the thick tube. A sleeve, which fits over the end portion of the thick tube and which has a circumferential step that supports the thin tube collar on the side remote from the thick tube, is welded to the thick tube. The wall thickness of the thick tube is mechanically reduced in a zone between the weld and the end of the tube to effect an endwise expansion of the thick tube and sleeve. This expansion causes the collar to be clamped between the sleeve step and the end face of the thick tube, and thereby forms the leak-tight joint. (L.C.L.)

22865 HIGH POWER X-RAY UNITS AND THEIR USE FOR SPECIAL APPLICATIONS IN IRRADIATION TECHNOLOGY. Hofmann, E. G. (AEG-Telefunken, Frankfurt am Main). Technical Meeting No. 8/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

Apart from the usual isotope equipment and electron accelerators, high power x-ray equipment can be used advantageously as a radiation source in the irradiation technique. X-ray units are easy to install, shield, and control. Several applications (e.g., pasteurization) are discussed with reference to x-ray equipment produced and planned. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 22877, 23521, 24819, 24824, 24832, 24842, 24917, 24927, and 24928.

22866 (BNWL-1317) COMPRESSIBLE FLUID FLOW (BNW PROGRAM GAS). Duane, Bernard H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 18 Sep 1969. Contract AT(45-1)-1830. 75p. Dep. CFSTI.

Battelle-Northwest Program, GAS is used to construct analytic streamtube integrals for the supersonic or subsonic flow of a real gas (having temperature-variant specific heats) through an open-loop or closed-loop succession of nozzles, oblique-shock diffusers, normal shocks, bypass flows with pressure-matched reentries, heat exchangers, burners, turbines, compressors, shock pumps, and other such elements simply characterizable in terms of mass, energy, momentum, or entropy transfer. Analysis versatility includes coupled variation of design specifications to meet performance requirements. (auth)

22867 (NYO-2930-15) BASIC STUDIES IN GAS-SOLID SUSPENSION. Final Report. Peskin, Richard L. (Rutgers-The State Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering). Feb 1970. Contract AT(30-1)-2930. 72p. Dep. CFSTI.

A theoretical and experimental study of turbulent gas-solid flow is reported. Topics in gas-solid heat transfer and momentum transfer are considered and a new nondimensional group which considers effects of particle separation and boundary layer penetration is presented. Mechanisms controlling particle motion in turbulent flow are discussed, together with the effects of particle motion on the gas turbulence. Gas-solid shear flow is considered and the importance of particle Reynolds stress emphasized. Thermal forces in gas-solid slip flow are computed and certain classical paradoxes discussed. Areas of application and problems for future research are included in the report. (auth)

22868 (TRG-Report-1807) HEATRAN: A FINITE ELEMENT CODE FOR HEAT TRANSFER PROBLEMS. Collier, W. D. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1969; Reprinted 1970. 49p. Dep. CFSTI (U. S. Sales Only). UK 6s.

HEATRAN is used to solve the heat diffusion equation over a two dimensional area of any shape or material distribution. Transfer by radiation across voids is allowed and special provision is made for narrow gaps. A wide range of boundary conditions are available. Over 1000 nodes may be used in either XY (slab) or RZ (cylindrical) geometry. The data requirements of the program are presented in detail. The use of the program is illustrated, and a brief description of the derivation of the equations is given. (auth)

22869 AN ANALYSIS OF THERMAL RESISTANCE AT A SOLID-STATIONARY LIQUID METAL INTERFACE DUE TO THE PRESENCE OF GAS CAVITIES. Yovanovich, M. Michael (Faculte des Sciences, Poitiers, France). Int. J. Heat Mass Transfer; 13: 93-103(Jan 1970).

A mathematical analysis of the thermal interface resistance was carried out on an idealized elemental heat flux tube for the case of a gas cavity interposed between a solid and a stationary liquid metal. The thermal resistance is expressed in terms of the thermal conductivities of the solid and liquid metal, the number of gas cavities per unit apparent area and a wettability number. A qualitative comparison between the theory and the test data of Bleunven et al. (Rev. Gen. Therm. 5, No. 53(1966)) is reported. Good agreement was observed within the assumptions made. (auth)

22870 INVESTIGATIONS ON THE PERMEABILITY OF METALLIC FILTERS, THEIR TEMPERATURE DEPENDENCE, AND THEIR PORE SPECTRA. Thomma, W.; Albano-Mueller, L.; Thuemmler, F. (Univ., Karlsruhe, Ger.). Planseeber. Pulvermet.; 17: 270-83(Dec 1969). (In German).

The gas flow through metal filters can be expressed by a second-order equation through a laminar term which is proportional to the velocity and a turbulent term, proportional to the square of the velocity. This enables two filter-specific permeability coefficients α and β to be determined, which depend on the density only. The measurements were carried out with nitrogen and argon. The laminar mass flow at higher temperatures was mainly limited by the increase in the gas viscosity and the decrease in the gas density. A further flow inhibition was produced in filters which were enclosed by a material with low thermal expansion by the thermal expansion of the filter. Due to the plastic deformation of the filter material this was irreversible. Hence, the variations of the gas properties were the only ones available for a temperature dependent control of gas flow. A study of the pore spectra showed that the average values obtained from the geometrical and flow-equivalent distribution functions practically coincide. The relations for metal filters are approximately the same as for loose powders. Thus, flow measurements alone permit quantitative conclusions concerning the pore radii. (auth)

22871 IMPROVEMENTS TO VALVES FOR THE CONTROL OF FLUID FLOW. White, William Paul; Durrands, Kenneth James (to United Kingdom Atomic Energy Authority). British Patent 1,181,658. 18 Feb 1970. Filed 13 Apr 1966.

A valve design for operation in circuits for the handling of hot liquids, such as liquid sodium circuits, is described. If the working of such a circuit is interrupted and the valve is allowed to cool to ambient temperature, heavy stressing of valve components, together with differential thermal expansion, may affect valve operation and allow leakage through an apparently closed valve. The valve described comprises a closure number and seating within a ported housing, the closure member being axially movable between valve open and closed positions by a screw and captive rotatable nut mechanism. A flexible bellows member is provided for sealing the closure member to the housing in order to isolate the screw and nut mechanism from the flow path of the valve, and a pack of conical disk spring washers is disposed between the nut and an abutment of the housing, arrayed so that after the nut is rotated to effect closure of the valve continued rotation displaces the nut axially, thereby resiliently deforming the pack of conical disk washers. An embodiment example is described in detail. Means may be provided for preheating at least that part of the housing bounding the flow path of the valve. (UK)

22872 APOLLO 13 LUNAR HEAT FLOW EXPERIMENT. Langseth, M. G. Jr. (Columbia Univ., New York); Wechsler, A. E.; Drake, E. M.; Simmons, G.; Clark, S. P. Jr.; Chute, J. Jr. Science; 168: 211-17(10 Apr 1970).

An experiment to make the first direct measurement of the lunar surface heat flow will be emplaced on the moon during the Apollo 13 mission. The measurement consists of making independent determinations of the vertical temperature gradient in the lunar surface, as a function of time, and of the thermal conductivity of the surrounding lunar soil. These data will provide a yearlong history of the heat flux through the upper 3 meters of the lunar subsurface. The balance of this heat budget will represent the steady-state loss of heat from the interior of the moon at the Apollo 13 site, Fra Mauro. The value of heat flow measured will set constraints on the interior temperature and composition of the moon. (auth)

22873 HEAT TRANSFER TO LIQUID METALS IN LONGITUDINAL ROD CLUSTERS. Borishanskii, V. M.; Gotovskii, M. A.; Firsova, E. V. At. Energ. (USSR); 27: 549-52(Dec 1969). (In Russian).

Experimental heat transfer studies to liquid metals were carried out at Prandtl numbers of 0.007 and 0.03 with longitudinal flow through rod bundles having spacing $S/d = 1.1$, 1.3 and 1.4. The rods were arranged on equilateral triangles. The data are plotted with the Nusselt number being given on a function of the Peclet number. An equation is also derived which expresses this relationship analytically. Values of the Nusselt number are tabulated for values of $s/d = 1.1$, 1.2, 1.3, 1.4, and 1.5 over the range of Peclet numbers varying from 200 to 2,000. Both turbulent and laminar flow are covered by this range of Peclet numbers. (TTT)

22874 A SUBCOOLED DNB INVESTIGATION OF FREON-113 AND ITS SIMILARITY TO SUBCOOLED WATER DNB DATA. Coffield, R. D. Jr.; Rohrer, W. M. Jr.; Tong, L. S. (Univ. of Pittsburgh). Nucl. Eng. Design; 11: 143-53(1969).

Subcooled departure from nucleate boiling (DNB) test data in Freon-113 vertically flowing in a uniformly heated circular tube is reported. With these data, extension by the existing scaling techniques for the critical heat flux (CHF) in the quality region to that for DNB in the subcooled region was verified. A method of predicting the high pressure water flow DNB heat fluxes by testing for DNB in a less expensive Freon-113 flow loop was also established. (auth)

Isotope Technology

Refer also to abstracts 22574, 22687, 22718, 22735, 22771, 22776, 22838, 22852, 22853, 22916, 23431, 23440, 23460–23463, 23520, and 24682.

22875 (GA-8928(Pt.2)) RADIOISOTOPE SPACE POWER GENERATOR. Annual Summary, July 1, 1967–June 30, 1968. Cruver, J. E.; Shevlin, R. G.; Leedy, R. L.; Steeger, E. J.; Unmack, F. L. (Gulf General Atomic, Inc., San Diego, Calif.). Dec 1969. Contract AT(29-2)-2564. 86p. Dep. CFSTI.

A 25 to 32-watt (BOL) generator design (nominally called the 30-watt generator) has been developed using ISOTEC technology: 400°C PbTe elements in a lightweight panel configuration. The modular construction of the ISOTEC generator has such flexibility that major components (thermoelectric panels and structural members) can be used directly to assemble generators with rated

outputs ranging from 20 to 100 watts. The application toward which the 30-watt generator design was directed was the NAVSAT (20-watt EOL) navigational satellite, where high reliability for five year life and output greater than 2-watts per lb were important. Development of test generators to verify design calculations began in July, 1967, and the first test generator (GCO1) had been completed and performance tested by the following June. GCO1 exceeded the predicted values of both output power and thermal efficiency by about 10%. Additional test generators are being built and tested in a continuing development program. (auth)

22876 (HIT-370) SPHERICAL CAPSULE TECHNOLOGY PROGRAM. HEAT SOURCE TECHNICAL REPORT. (Hittman Associates, Inc., Columbia, Md.). Jan 1969. 310p. Dep. CFSTI.

Research and development efforts devoted to engineering optimization of a spherical radioisotope heat source for a low-temperature thermoelectric generator are described. Design and operation of a demonstration model of the heat source are also described. (J.R.D.)

22877 (MMM-3824-43) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 12, October 1-December 31, 1969. (Minnesota Mining and Mfg. Co., St. Paul, Electrical Products Group). 31 Jan 1970. Contract AT(30-1)-3824. 170p. Dep. CFSTI.

During this quarter the design for all components and their associated drawings were completed for the top cover assembly of PMC-2. The PMC-2 converter proper which was assembled in the previous quarter was processed. During initial processing opens and shorts occurred which precipitated a failure analysis consisting of x-rays, partial disassembly, replacement of eleven couples and Min K-1301, rewelding and reprocessing. This effort was completed and PMC-2 is now ready for initial performance and stability testing. In addition to the failure of PMC-2, converter PMC-1B experienced an open after approximately one year of operation. A detailed analysis of these two failures which appear to be related is in progress. The cause for the failures appears to be copper contamination of the thermoelectric materials, but what initiated the reaction is unknown at the present time. (auth)

22878 (ORNL-IIC-22(Pt.4)) SELECTED ABSTRACTS OF WORLD LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES (FROM NSA, OCTOBER-DECEMBER 1969). Gerrard, Martha; Baker, P. S. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 54p. Dep. CFSTI.

Approximately 600 abstracts of domestic and foreign publications on production and use of radioisotopes and radiation, selected from the October to December 1969 issues of Nuclear Science Abstracts, are presented. (auth)

22879 (SC-M-70-157) ANNOUNCEMENT OF COMPUTER CODE HRS017: A CODE FOR THE COMPUTATION OF THE TRAJECTORY AND REENTRY ENVIRONMENT FOR NUCLEAR SYSTEMS DECAYING FROM MULTIPLE REVOLUTION ELLIPTICAL ORBITS (SC-RR-69-378 AND SC-RR-70-143). Spahr, H. R. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 6p. Dep. CFSTI.

Computer code HRS017 calculates and prints in tabular form the trajectory and reentry environment for nuclear systems decaying from multiple revolution elliptical orbits, using a closed form approximate solution. The code also prepares a reentry environment punched card data deck for input to the Sandia Laboratories Charring Materials Ablation code. (auth)

22880 (WANL-3800-24) SNAP-23A EMS-ELECTRICAL HEAT SOURCE FAILURE ANALYSIS REPORT. Hoppe, A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Feb 1970. Contract AT(30-1)-3800. 244p. (WANL-TR-(SS)-1). Dep. CFSTI.

SNAP-23A is the designation of a program to develop an advanced terrestrial radioisotope, thermoelectric power system capable of delivering 25 to 100 W(e) for 10 years. An electrically heated mockup system (EMS) was built and on thermal test when heater input power irregularities and a cover gas leak caused shutdown. A task force was organized to analyze the cause of failure, effect repairs, rebuild the unit, and resume thermal testing. The disassembly, analysis, testing, cause of failure, redesign, rebuilding procedures, and successful retesting of the system are described. The prime cause of operational difficulty was electrical shorting of input heater power through carbon-contaminated lava insulators in the heaters. A contributing problem was excessive oxidation of Ag-Cu braze alloys on ceramic-to-metal insulated electrical feedthrough seals. The seals were eliminated in the redesign, and the sources of carbon contamination (cleaning solvents and outgassing products) were eliminated by changes in reassembly procedures. The effectiveness of these measures is shown by the fact that the rebuilt EMS has now operated successfully for over 11,800 hours. (auth)

22881 MATERIALS FOR RADIO-ISOTOPE HEAT SOURCES. Proceedings of the 1968 Nuclear Metallurgy Symposium Held in Gatlinburg, Tennessee on October 2-4, 1968. Thomas, D. E.; Harms, W. O.; Huntoon, R. T. (eds.). Nuclear Metallurgy, Volume 14. New York; American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. (1969). 360p. (CONF-681002).

A total of 22 papers was presented at the meeting. A separate abstract was prepared for each. (G.M.C.)

For abstracts of individual papers see: 22852, 22853, 22882-22894, 22916, 23431, 23440, and 23460-23463.

22882 APPLICATIONS OF RADIOISOTOPE SPACE POWER SYSTEMS. Lafleur, Joseph D. Jr. (Atomic Energy Commission, [Washington, D. C.]). Nucl. Met., Met. Soc. AIME; 14: 1-27 (1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

In the 1970's, the national space program will include several categories of missions which will require new technical considerations in the design for on-board supply of electrical power. In several categories, the competitiveness of nuclear power systems depends on new factors relating to the new mission environments involved and the technology that could be available in the coming years. It is essential that power system development objectives be realistic in view of the likely missions and the probable competition. The mission categories are examined, competitive power concepts are compared, and development objectives for various isotopic power systems are derived. (auth)

22883 TERRESTRIAL ISOTOPE POWER SYSTEMS IN PERSPECTIVE. Selken, Stanley J. (Atomic Energy Commission, Washington, D. C.); Bair, William A. Nucl. Met., Met. Soc. AIME; 14: 28-49(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The history, present status, and projected future of terrestrial isotopic power sources for energy ranges from microwatts to kilowatts is investigated. Current and potential applications, along with economic considerations, of these interesting power sources are discussed. British and Russian efforts in the field of terrestrial isotopic power sources are briefly mentioned. The Atomic Energy Commission's basic developmental precepts and program philosophy are defined, and the relative priorities of technological effort are identified. Areas of technological weakness are summarized and it is suggested that public and official acceptance of widespread deployment of radioisotope power sources may require careful control and international regulation. (auth)

22884 SAFETY CONSIDERATIONS FOR RADIOISOTOPE POWER SYSTEMS. Dix, George P. (Atomic Energy Commission, Washington, D. C.). Nucl. Met., Met. Soc. AIME; 14: 50-70 (1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The safety considerations involved in the use of radioisotope power systems in space and terrestrial applications is reviewed and therefrom the safety requirements and design restraints placed upon the radioisotope fuel, heat source, and power system are derived. This survey paper is not a statement of official AEC requirements, rather the safety considerations are discussed and safety design and test requirements were compiled from existing applicable guidelines and past experience on radioisotope power systems that were deployed. (auth)

22885 RADIOISOTOPE REQUIREMENTS AND AVAILABILITIES FOR POWER APPLICATIONS. Jordy, George Y.; Lindsey, Wilton J.; Powers, James A. (Atomic Energy Commission, Washington, D. C.). Nucl. Met., Met. Soc. AIME; 14: 71-86 (1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Firm and probable needs for radioisotopic power are given along with near and far-term availabilities. The following isotopes are considered; plutonium-238, curium-244, polonium-210, thulium-170, cobalt-60, promethium-147, and strontium-90. Plutonium-238 and curium-244 have limited near-term availability due to current shortage of feedstock; however, production could be increased in the early 1970's by irradiating feedstocks (neptunium-237 and americium-243) recovered from power reactor spent fuels. In contrast to the transplutonium isotopes, suitable feedstocks are readily available for polonium-210, cobalt-60, and thulium-170. Substantial production acceleration

of cobalt-60 and thulium-170 could be achieved in about one year. The near-term availabilities of polonium-210, strontium-90, and promethium-147 are limited by the capability of AEC developmental facilities to perform separation, conversion, and encapsulation operations. (auth)

22886 RADIOISOTOPES FOR POWER APPLICATION. Griffo, J. S. (Atomic Energy Commission, Washington, D. C.). Nucl. Met., Met. Soc. AIME; 14: 87-95(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The decay energy of selected radioisotopes provides a unique source of heat which can be coupled with static and dynamic power conversion units to provide useful quantities of electrical energy. Based on selection criteria the fission and neutron produced isotopes ^{238}Pu, ^{210}Po, ^{244}Cm, ^{170}Tm, ^{90}Sr, and ^{147}Pm are primary contenders for potential use in heat sources for space applications. Currently, major effort is directed toward the development of fuel forms of ^{238}Pu, ^{210}Po, and ^{244}Cm. A brief evaluation of the potential of these isotopes and how this potential is determined from their properties is presented. (auth)

22887 PROPERTIES AND FABRICATION OF PLUTONIUM FUEL FORMS. Abrahamson, S. G. (Mound Lab., Miamisburg, Ohio). Nucl. Met., Met. Soc. AIME; 14: 96-108(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Plutonium metal, plutonium–zirconium alloys, solid solutions, composite fuels, and PuO_2 microspheres can be used as heat source fuels. Plutonium dioxide has a relatively high melting point and low vapor pressure and is suitable for large sources. In the form of microspheres it has low aqueous solubility, low ingestion hazards, and low inhalation hazards. The microspheres were produced by two methods. In one method rough PuO_2 particles were melted and spheroidized in a plasma arc. In the sol-gel method a stable plutonium colloid (sol) was dehydrated on a column which produced spherical particles. The spheres were calcined and sintered for the desired product. (auth)

22888 PROPERTIES AND FABRICATION OF ^{210}Po FUEL FORMS. Kershner, C. J. (Mound Lab., Miamisburg, Ohio). Nucl. Met., Met. Soc. AIME; 14: 109-124(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The available literature data on ^{210}Po are reviewed, especially information of significance in the use of ^{210}Po as an isotopic fuel. However, the major portion of this paper deals with the data from research and development for isotopic fuel applications. The methods are described for producing a fuel form which best utilizes the attributes of a high specific power, short half-life, alpha emitter; namely, ^{210}Po. Fabrication techniques and properties of other fuel forms, such as matrices, are also covered. Applications, such as the POODLE space thruster, demonstrate fuel form concepts in actual development. Investigations are described which have the goal of improving present polonium fuel forms, especially their high-temperature chemical stability. (auth)

22889 PROPERTIES AND FABRICATION OF ^{244}Cm AND ^{90}Sr FUEL FORMS. McHenry, R. E. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME; 14: 125-55(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The compounds $^{244}Cm_2O_3$, SrO, $SrTiO_3$, and Sr_2TiO_4 are being developed for use as isotope fuel forms for generation of high temperature heat fluxes which can be converted to electric power. The efficient and safe use of these isotope fuels requires that a suitable compound be prepared and fabricated into a suitable form with fully characterized physical and chemical properties. The task elements for accomplishing this program consist of: compound preparation; compound fabrication; compound characterization; source design; and prototype testing. Techniques developed for accomplishing these tasks and the results achieved to date are reviewed. (auth)

22890 PROPERTIES AND FABRICATION OF PROMETHIUM FUEL FORMS. Drumheller, K. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Met., Met. Soc. AIME; 14: 156-70(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Most experience in processing promethium was with the Pm_2O_3 fuel form. Promethium oxide at 90% of theoretical density has a specific power of 0.27 watt/gm. The half life is 2.62 years. Promethium is a soft beta emitter and is fairly easily shielded. Promethium oxide was densified by conventional pressing and sintering, hot pressing, and pneumatic impaction. Other processing methods are being investigated. Cold pressing, followed by sintering in air, was a suitable process for fabrication of simple configurations in pellet sizes up to approximately one inch diameter by ½ inch thick. With larger pellets, pressing and sintering may be suitable but self-heating may introduce thermal stress problems. Pneumatic impaction was utilized for densification of encapsulated promethium oxide. This process produced a very high density fuel form. Encapsulation materials have included a shielding material such as tantalum and a supplemental clad to provide compatibility with the environment. Closures were made by TIG and electron beam welding. Most fabrication was done in lead shielded glove boxes. The fuel material was handled with tongs and local shielding was used where possible. Heat sources were fabricated for several experimental programs. (auth)

22891 PROPERTIES AND FABRICATION OF ^{170}Tm OXIDE TARGETS. Keski, J. R.; Smith, P. K. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Met., Met. Soc. AIME; 14: 171-83 (1969). (DP-MS-68-24).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Natural thulium sesquioxide is a candidate target material to produce ^{170}Tm fuel forms for direct application in short-lived radioisotopic heat sources. Physical and chemical properties of Tm_2O_3 are reviewed. Fabrication of oxide wafers to 97% of theoretical density and characteristics of wafers irradiated to an activity of about 2 W/gm are described. (auth)

22892 LAUNCH-PAD ACCIDENT ENVIRONMENTS. Jeffers, S. L.; Kite, F. D. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Met., Met. Soc. AIME; 14: 271-9(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

A determination of the effects of a launch-pad accident requires that the principal environments be well characterized. The environments of explosion and fire resulting from a missile abort on or near the launch pad are discussed. (auth)

22893 EFFECTS OF THE REENTRY ENVIRONMENT ON RADIOISOTOPE HEAT SOURCES. McAlees, S. Jr. (Sandia Labs., Albuquerque, N. Mex.). (SC-DC-68-2161). Nucl. Met., Met. Soc. AIME; 14: 280-97(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Use of radioisotope heat sources in space missions requires that adequate safety be provided in the event that mission aborts lead to reentry of the nuclear system. The initial reentry conditions, along with the spacecraft configuration resulting from the abort, define the environment to which the nuclear system is exposed. A typical program to define the environment and system response is discussed. Materials and design concepts selected to provide intact reentry for a particular system are presented. (auth)

22894 EFFECT OF EARTH BURIAL OF RADIOISOTOPE HEAT SOURCES. Jeffers, S. L.; Baker, F. L. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Met., Met. Soc. AIME; 14: 298-308 (1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Earth burial of radioisotope heat sources was of interest because increased emphasis was placed on disposal by intact reentry. With an intact system, the heat source may penetrate the earth during initial impact, or be buried by blowing sand or shifting soil over a period of time. Once buried, the heat source's temperature will rise, causing several reactions occurring singly or in combination: corrosion or chemical attack by the soil; melting of the container; melting of the soil; or fuel property degradation. Studies were directed toward a better definition of high-temperature soil properties and the inclusion of these properties in heat transfer models. A series of actual burial tests using electrical heaters both in the laboratory and in the field are also under way. It may be possible to dispose of radioisotope heat sources by adjusting their geometry so that they will melt their way deep into the earth. (auth)

22895 PRODUCTION AND USE OF ^{238}Pu AS AN ENERGY SOURCE. Beisswenger, H. Technical Meeting No. 7/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

The α-emitter ^{238}Pu can be used for radioisotopic generators in pacemakers and in space. Pure ^{238}Pu emits very little γ and neutron radiation and has a specific power of 0.55 W/g. Besides the production in fuel elements fully enriched in ^{235}U, ^{238}Pu can be pro-

duced by neutron irradiation of ^{237}Np. An irradiation experiment, in which Np is used in the form of a Fe-NpO_2-cermet, is described in details. (auth)

22896 NUCLEAR BATTERIES. Matheson, W. E. (McDonnell Douglas Corp., St. Louis). Technical Meeting No. 7/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

It is not yet widely recognized that nuclear batteries are practical and economic devices. Factors relating to the emerging competitiveness of low power batteries are presented. Nuclear batteries are defined and described. The unusual significance of matching battery design to the application leads to discussion of factors relating to applications design efficiency. Designs must consider the radiation level constraints of the application, a factor playing no role in the application of chemical batteries. A dimensionless figure-of-merit is developed in terms of the volumetric specific power and the dose rate, which yields a useful criterion for comparing the design efficiency of nuclear batteries. Significant cost factors are identified, including the cost of energy and logistics. Competitiveness of the nuclear battery is derived from factors other than raw energy cost. (auth)

22897 RADIOISOTOPIC HEAT AND ELECTRIC GENERATORS. Fradkin, G. M. Technical Meeting No. 7/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

In 1963 to 1968 radioisotopic thermoelectric generators fueled with ^{144}Ce, ^{90}Sr, ^{137}Cs, ^{238}Pu and ^{210}Po were developed in the USSR. The positive experience of the development and operation of isotopic power generators and the increasing capability of industry for producing radioactive isotopes in large quantities leads to the prediction that the isotopic energy industry in the USSR should develop on a large scale. (auth)

22898 RECENT DEVELOPMENT IN RADIOISOTOPE BATTERIES FOR MEDICAL PURPOSES AND MINIATURIZED ELECTRONICS. Ream, J. T.; Perry, L. W. (Gulf General Atomic Inc., San Diego, Calif.). Technical Meeting No. 7/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Radioisotope batteries are under development for a power range between 0.1 and 100 electrical milliwatts. Nuclear batteries employing the metallic thermoelements with a redundant thermopile design operating at low temperature (maximum 250°C for long life operation) up to 10 years are discussed. The design described produces a rugged long life nuclear power source for many applications including a nuclear battery in the 100 microwatt range for use with implantable cardiac pacemakers and in the 50 to 100 milliwatt range for powering long life underwater oceanographic buoys. Other applications taking advantage of the small size, or long life and high reliability can be envisioned. (auth)

22899 ISOTOPIC POWER GENERATORS. Gaunt, J.; Wiblin, E. R. Technical Meeting No. 7/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Developments in the UK in the field of electricity generation from isotope decay heat are reviewed. Present applications are evaluated and future users for UK generators currently available from industry are discussed. (auth)

22900 RADIOISOTOPE POWER SOURCES FOR TERRESTRIAL APPLICATIONS. Morrison, J. H. Technical Meeting No. 7/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Radioisotope Thermoelectric Generators (RTG's) are now a reality for both space and terrestrial applications. The early development work initiated in 1960 on the SNAP-7 series of generators has evolved to the point where RTG's for terrestrial applications are commercially available from several companies in the United States, Great Britain and France. Reliability is such that power warranties for at least five years are offered and available power levels span the range from milliwatts to about 50 watts electrical. Many political, economic, and technical problems present themselves when a device containing radioactive material is contemplated for an application. One of the continuing areas for technical endeavor, thermal management and heat rejection systems, is discussed. (auth)

22901 RADIOISOTOPE HEAT SOURCE AND SYSTEM DEVELOPMENTS. Botts, W. Venn Jr. (Atomics International, Canoga Park, Calif.); Johnson, D. R. Technical Meeting No. 7/9 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Recent advances in radioisotope heat source and conversion technologies and their impact on radioisotope system performance are presented. The specific developments reported are a high-temperature refractory metal fuel capsule and an advanced cascaded thermoelectric converter which promises 10% conversion efficiency. These developments are shown to allow the design of long life space electrical power systems with a specific power of greater than 3 watts/lb. (auth)

22902 RADIATION: AN INDUSTRIAL TOOL. Jefferson, S. Technical Meeting No. 8/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Developments in the UK in the use of radiation in the fields of medical sterilization, agriculture, food preservation, and chemical processing are briefly reviewed. The development of industrial plants for these purposes with one developed for using large sources of cobalt-60 for gamma irradiation is also described. (auth)

22903 RADIOISOTOPES FOR STERILIZATION AND INDUSTRIAL APPLICATIONS. Warland, H. M. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Technical Meeting No. 8/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The development and manufacture of a number of process irradiation plants in Canada, are described. These facilities have been constructed for radiosterilizing medical products and other industrial applications. Equipment using radioisotopes is now commonplace in conventional manufacturing plants. The background work required to convert the isotope from a research to a production tool is related. (auth)

22904 USE OF RADIOISOTOPES FOR THE PURPOSE OF STERILIZATION. Christen, H. (Sulzer Bros. Ltd., Winterthur, Switzerland); Muenzel, F. Technical Meeting No. 8/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

Evidence is presented which shows that radiation sterilization of medical supplies especially syringes, bandages, sutures, etc., has been successful. Both the scientific bases and the practical applications of gamma irradiation plants are discussed. (auth)

22905 PROBLEMS INTRODUCED BY EMPLOYING RADIOSTERILIZATION ON AN INDUSTRIAL SCALE. Rondenay, F. Technical Meeting No. 8/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

The efficiency and easy control of gamma radiosterilization together with quick expansion of disposable medical items explain the increasing number of radiosterilization plants. Testing and preserving the sterility are the two main points in the case of mass production. Irradiation of other products, such as drugs, in order to sterilize them or control their level of pollution is considered. The process dose should then be reexamined. Economics of irradiation plants depend of their output. It is however possible to optimize a plant for a predetermined capacity. (auth)

22906 DANISH EXPERIENCES WITH RADIATION STERILIZATION OF MEDICAL SUPPLIES. Holm, N. W. (Danish Atomic Energy Commission, Riso); Christensen, E. A. Technical Meeting No. 8/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Radiation sterilization of disposable medical products was started in Denmark in 1958. Since 1961 such products have been irradiated on an industrial scale at the linear accelerator plant at Risö. The technical and commercial development has been rapid and successful, and in 1967 a commercial radiation establishment, RADEST A/S, was inaugurated. The technical part of the method is discussed, and the bacteriological research leading up to the National Health Service recommendations is described. (auth)

22907 THE USE OF RADIOISOTOPES AND ACCELERATORS FOR STERILIZATION PURPOSES AND OTHER INDUSTRIAL APPLICATIONS. Yuan, H. C.; Antoni, F.; Beswick, C. K. (International Atomic Energy Agency, Vienna). Technical Meeting No. 8/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The industrial aspects of using radiation sources, both radioisotopes (principally ^{137}Cs and ^{60}Co) and particle accelerators, in the radiosterilization of medical supplies and the radiation processing of polymers, are reviewed. (L.C.L.)

22908 METHOD OF ISOTOPE CONCENTRATION. Schunck, Theodor Ernst (to Friedrich Uhde GmbH). U. S. Patent 3,503,710. 31 Mar 1970. Priority date 24 Jan 1961, Germany.

A multistage process is presented for producing deuterium enriched water in a preconcentration stage conducting counter current isotope exchange between hydrogen and ammonia in a series of isotope exchange zones. (TSS)

22909 METHOD OF PRODUCING A RADIOACTIVE SOURCE AND RADIOACTIVE SOURCE PRODUCED THEREBY. (to Centre d'Etude de l'Energie Nucleaire). British Patent 1,186,534. 2 Apr 1970. Priority date 2 Jun 1966, Luxembourg.

A method is described for producing a plutonium or uranium radiation source by dissolving the radioactive salt in a polymerizable monomer and subsequently polymerizing the monomer. The method may also apply to the use of non-radioactive but radioactivable material which, after polymerization of the monomer, is subjected to irradiation to render it radioactive. (J.C.W.)

22910 ATOMIC POWER FOR PACEMAKERS. J. Amer. Med. Ass.; 212: 559(27 Apr 1970).

Continuing tests of a ^{238}Pu-fueled cardiac pacemaker, implanted in seven dogs at the National Heart and Lung Institute, Bethesda, Md., indicate the device may prove clinically useful. Characteristics of the fuel and the electronic pacing circuit are briefly described. (L.C.L.)

22911 THEORY OF SEPARATION CASCADES AT HIGH ENRICHMENTS PER SEPARATION STAGE. Kolokol'tsov, N. A.; Laguntsov, N. I. At. Energ. (USSR); 27: 560-2(Dec 1969). (In Russian).

The theory for separating a multi-component isotopic mixture has been sufficiently developed, when the change in isotope concentration in one separation stage is small. The theory is more complex if it cannot be assumed that the change in isotope concentration per separation stage is sufficiently small. In this case the increase in isotope concentration is a function of the isotope concentration and the separation coefficient per stage θ. The basic enrichment and depletion equations are derived for these conditions. If the required withdrawal rate, the withdrawal concentration, the feed concentration and rejection concentration are given, the rejection rate is definitely determined. From the equations and boundary conditions it is possible to determine the number of stages in the cascade having a given distribution of productivities. (TTT)

22912 PRODUCTION AND APPLICATION OF ATOMIC BATTERIES. Schaefer, H. (Institut fuer Angewandte Isotopenforschung, Berlin). Isotopenpraxis; 6: 1-11(Jan 1970). (In German).

Information is summarized on production of nuclear batteries including data on radionuclides, source production, conversion systems, safety, and cost. Information is also included on uses of nuclear batteries in space, on land, on the sea, and in medicine. Internally used sources, and trends in evolution are also discussed. (J.R.D.)

22913 NUCLEAR POWER ON THE MOON. Int. At. Energy Agency Bull.; 12: No. 1, 9-12(1970).

A SNAP-27 unit was placed on the moon during the Apollo 12 mission to provide all the electricity for continuous 1-yr operation of all NASA instruments and support subsystems. The design and operation of this ^{238}Pu-fueled thermoelectric generator is described. (L.C.L.)

22914 OPTIMAL CONTROL OF THE RADIOACTIVE VOLTAGE STANDARD. Braudaway, David W. (Sandia Corp. Albuquerque, N. Mex.); Mohler, Ronald R. ISA (Instrum. Soc. Amer.) Trans.; 8: 202-7(1969).

To simplify operation of the radioactive voltage standard, control of the system balance is necessary. Before the control can be synthesized, a system mathematical model must be developed. A system mathematical model; a suitable performance index; and the developed, optimal control are described. Also discussed are the results of a computer simulation of the system behavior and a means of realizing the developed control. (auth)

Materials Testing

Refer also to abstracts 22878 and 23504.

22915 (BNWL-1279, pp 8.1-24) NONDESTRUCTIVE TESTING. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Results of investigations concerning multidimensional representation of eddy current test signals are reported along with development of thermal transducer, infrared, and ultrasonic testing methods. Development of a transducer calibration method is also reported. Results of Mössbauer backscatter studies are summarized. (J.R.D.)

22916 ULTRASONIC TEST SUPPORT FOR CONTAINER INTEGRITY ASSURANCE. Steffens, R. W. (Battelle Memorial Inst., Richland, Wash.). Nucl. Met., Met. Soc. AIME; 14: 223-33 (1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Ultrasonic nondestructive testing techniques, when properly integrated into the capsule development program, can be used to establish the container integrity of fueled isotope capsules. The ability of ultrasound to detect close fitting cracks, and to obtain complete inspection of the container volume, advantageously supplements the information normally acquired through radiographic, dye penetrant, and metallographic analysis. Ultrasonic test support during an isotope capsule development and fabrication program was classified into four phases with each phase having specific quality control and ultrasonic test development objectives. The remote ultrasonic verification of the integrity of fueled SNAP-21 capsules illustrates the effectiveness of applying a cooperative approach between capsule fabrication and nondestructive testing personnel to assure capsule certification. (auth)

22917 IN-SERVICE INSPECTION OF STEEL NUCLEAR REACTOR PRESSURE VESSELS. SURVEY OF PRESENT EXPERIENCE. Wylie, R. D. (Southwest Research Inst., San Antonio). At. Energy Rev.; 8: 127-72(Mar 1970).

The development of nuclear power has brought about an interest in measures for assuring the continued structural reliability of the pressure components of the nuclear reactor system. Present experience in the application of nondestructive testing techniques to the in-service inspection of steel reactor pressure vessels primarily for water-cooled reactor service is discussed. Consideration is given to the limitations of the various techniques and some areas of required development are discussed. Examples are given of some early reactor inspections in the United States, Italy, and Japan and some of the equipment which has been used in making these inspections is described. Some new approaches are indicated and, in fact, must be developed if economical reliability assurance is to be obtained. (auth)

22918 THE NONDESTRUCTIVE INSPECTION OF TUBINGS FOR DISCONTINUITIES AND WALL THICKNESS USING ELECTROMAGNETIC TEST METHODS. Forster, Friedrich (Institut Dr. Foerster, Reutlingen, Ger.). Mater. Eval.; 28: 21A-5; 28A-31(Apr 1970).

The testing of the inner surface of tubes with spinning eddy probes is described and experimental results are given of magnetic stray field on tubes, according to wall thickness, diameter, magnetization field, and material. Also described is failure testing of tubes by measuring the magnetic flux with microprobes. Magnetic stray flux testing with inner probes for thick-walled tubes is also described. The paper also deals with the failure testing of tubes with extremely high failure resolution as applied on cannings. Finally, it discusses the combination of failure testing and measurement of wall thickness. (auth)

Radioactive Material Handling

Refer also to abstracts 22858, 22862, and 23051.

22919 (BNWL-1287) FAIL SAFE INSTALLATION OF A VACUUM SYSTEM FOR SPUTTERING APPLICATIONS IN A GLOVE BOX. Coleman, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

In the development of a method to contain polonium as an isotopic heat source the hollow microsphere concept was originated. In order to make this concept work many new fabrication pro-

cesses were required. One of these processes involved sputtering and vacuum evaporation techniques. Due to the biological hazard, it was mandatory that the equipment be operated in a fail safe condition. The procedures involved in installing a vacuum system into a radiation glove box and the modifications necessary to install a sputtering unit in this box are discussed. A major consideration in the installation of the vacuum system and sputtering unit in the radiation glove box was to provide a mechanism so that any malfunction would result in immediate shut down. That is to say, that if the power or any one of the components failed, the unit would shut down in such a way that no release of radioactive material would occur. The box in normal operation is maintained at −1 in. of water. All mechanisms fail in such a manner as to maintain this negative pressure in the box. The interlock system has been in operation for over 6 months. During this period, it has shut the system down several times due to abnormal glove box pressure and inadequate water flow with no adverse effects. (auth)

22920 (CEA-CONF-1411) EVOLUTION IN THE CONCEPTION AND DEVELOPMENT OF RESEARCH CELLS FOR RADIOCHEMISTRY. Lefort, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1969]. 23p. [In French). (CONF-691008−11). Dep. CFSTI (U.S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

The design and development of research cells for radiochemistry in France are reviewed from the first pilot plants of 1954 to 1958 to the present. Actual cells developed and constructed for aqueous and dry chemical processes are described. The construction costs and the costs for the maintenance and operation of these cells are considered. (J.S.R.)

22921 (CEA-CONF-1419) CELLS ASSOCIATED WITH NUCLEAR REACTORS. PHILOSOPHY AND EVOLUTION OF THEIR CONCEPTION. Boulinier, Claude; Meunier, Jean; Puychevrier, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 11p. (In French). (SM-125/19; CONF-691008-6). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

Reactors can be classified into three large categories: research reactors, prototype power reactors constructed on a semi-industrial scale, and industrial power reactors. Each of these three types of reactors places corresponding problems on the type of hot cell associated with them. On the basis of concrete examples, the types of hot cells needed, the inferences which can be drawn from experiences with them, and the methods and means which seem most likely to give satisfactory and economic results are described. The hot cell associated with the research reactors EL-3 and OSIRIS and the hot cells associated with the prototype power reactors G2−G3 and the Phenix reactor are discussed from these viewpoints. The industrial reactors require hot cells with characteristics very similar to the semi-industrial reactors and therefore no specific examples are given. Suggestions are made for the simplification and standardization of hot cells. (J.S.R.)

22922 (CEA-CONF-1424) WATER AND AIR TIGHT DOORS FOR $\beta-\gamma$ ENCLOSURES. Fradin, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 17p. (In French). (SM-125/17; CONF-691008-9). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

The water and air tight doors constitute one of the principal elements of installations for the manipulation of radioactive materials. Two doors, which solve some of the practical problems of exploitation of such enclosures, are described. The first is a transfer door which can be installed either directly on the enclosure or on a transfer base. The second is a door for the admission of the radioactive materials. Each door is described in detail with the use of sketches and illustrations. (J.S.R.)

22923 (CEA-CONF−1426) NORMALIZED SYSTEM FOR TECHNICAL MEANS OF PROTECTION AND IMPROVEMENT OF SAFETY IN HOT LABORATORIES. Vertut, Jean; Seran, Robert; Guilbaud, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 24p. (In French). (CONF-691008−15; SM−125/50). Dep. CFSTI (U.S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

The progress made in France in the development of normalized systems for shielding, remote handling, transfer, monitoring, and fire safety in hot laboratories is summarized. The bases of the normalized materials system are given. The normalized elements in shielding, air tightness and tight transfer, shielded containers and shielded transfer elements, and handling methods are also described. (J.S.R.)

22924 (CEA-R-3946) NEUTRON INTERACTION IN AIR BETWEEN CYLINDRICAL VESSELS CONTAINING EITHER URANIUM OR PLUTONIUM SOLUTIONS. Bouly, Jean-Claude; Caizergues, Robert; Deilgat, Edouard; Houelle, Michel; Maubert, Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 99p. (In French). Dep. CFSTI (U. S. Sales Only).

The main experimental results obtained on the neutron interaction, in air, between cylindrical containers filled with uranium and plutonium solutions are given. Comparisons have been made between the uranium and the plutonium. The results obtained from various calculation methods were compared with experimental data. Interaction criteria were drawn up for systems of tubes, in air, filled with uranium and plutonium-containing solutions. (auth) (France)

22925 (CEA-R-3961) CONTROL OF FISSILE-MATERIAL LOSSES DURING RAPSODIE FUEL REPROCESSING. Jover, Pierre; Janot, Pierre; Gey, Jean-Francois; Malet, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1970. 24p. (In French). Dep. CFSTI (U. S. Sales Only).

Equipment has been designed to control losses of fissile materials in leached hulls during the Rapsodie fuel reprocessing in the pilot plant A. T. 1 (La Hague). The leached hulls are placed in a basket and irradiated using a neutron generator; the delayed neutrons emitted after irradiation are then counted. It is possible to check a basket containing 10 kilos of leached hulls in 30 minutes, and to detect 50 mg of uranium 235. (auth) (France)

22926 (EUR-4292) A STUDY OF THE RADIOLOGICAL ASPECTS OF THE MANUFACTURE AND USE OF RADIOACTIVE LIGHTNING CONDUCTORS. Delhove, J. (Association pour le Controle des Applications de l'Energie Atomique, Brussels (Belgium)). 1970. Contract 035-67-7-PSTB. 76p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 9,-.

The development of radioactive lightning conductors is outlined. An investigation showed that they are in fairly common use in several Community countries; out of eight firms listed, six are in France, Belgium and Italy. A description is given of the various models manufactured. The radiological hazards of their manufacture and use are considered. The field of radioaction and weatherproof properties were measured on 10 new or used models. A discussion of some illustrative incidents and particular aspects of Community and U. K. legislation in this field is included. (auth)

22927 (IDO−12040(Suppl.4)) RADIOACTIVE WASTE DISPOSAL DATA FOR THE NATIONAL REACTOR TESTING STATION, IDAHO. Osloond, Joe. H.; Newcomb, D. L. (Idaho Operations Office (AEC), Idaho Falls). Apr 1969. 15p. Dep. CFSTI.

Data on radioactive waste associated with reactor operations or research studies at the National Reactor Testing Station during 1968 are reported. The radioactive wastes are identified according to quantity, physical form, nuclide content, and the installation or area originating the waste. Radioactive waste data for the years 1955 through 1967 are also given. A more detailed presentation of disposal data for years prior to 1968 is available in reports IDO-12040 and IDO-12040 Supplements No. 1, No. 2, and No. 3. (auth)

22928 (MRR-56) CRITICAL AND SAFE PARAMETERS FOR PLUTONIUM AND PLUTONIUM COMPOUNDS. Thomas, Wolfgang (Technische Hochschule, Munich (West Germany). Institut fuer Mess- und Regelungstechnik). Apr 1969. 40p. Dep. CFSTI (U. S. Sales Only).

Critical and safe parameters (mass, concentration, volume, diameter of infinite cylinder, diameter of infinite slab) have been established for plutonium and plutonium compounds. In all cases full reflection is assumed. The plutonium fuel is pure ^{239}Pu. A review of plutonium literature is given and criticality calculations were made by means of the DTF-transport code using four and sixteen energy groups. (J.C.W.)

22929 (NP-18181) THE TREATMENT OF EUROCHEMIC MEDIUM LEVEL WASTE BY THE NEUTRALISATION SELF-SOLIDIFICATION PROCESS (N.S.S.P.): STATUS OF THE TECHNOLOGICAL DEVELOPMENT WORK ON 31ST DECEMBER 1968. Hild, W.; Lazzaretto, J. F.; Lopez-Menchero, E.; Burny, E. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Feb 1969. 83p. (ETR-242). Dep. CFSTI (U. S. Sales Only).

The status of the development work on the technological aspects of the Neutralization Self-Solidification Process (NSSP) is described on the basis of recent investigations performed up to December 31,

1968, when further development activities stopped. A description of a simple NSSP pilot plant, using an industrial self-cleaning screw heat-exchanger, as evaporator in the concentration step, is given together with the results of the inactive tests performed. Although a total of 6.5 m^3 medium-level wastes were successfully solidified with a volume reduction factor of 4 to 5, the self-cleaning screw conveyor heat-exchanger tested is not recommended, as it does not avoid incrustation and, hence, the increased risk of wear. Furthermore, it operates at rather low evaporation efficiency. However, the technological solution adopted for chemical waste treatment has been successfully carried out. Similarly, the alternative approach using a small-scale drum-drier testing model is not recommended because considerable dust formation cannot be avoided and because comparable low evaporation efficiency was encountered. A detailed description of the development of a prototype wiped thin-film evaporator testing model is given together with the results of concentration tests performed and the conclusions drawn. Due to the first experience gained and the rather good evaporation efficiency, the use of this evaporation method in the NSSP concentration step is judged optimistically. Finally, another promising approach, based on a mechanical deliquefication combined with a concentration of the mother liquors, is described and the results of the development work performed are presented. (auth)

22930 (WASH–1145) DIRECTORY OF SHIPPING CONTAINERS FOR RADIOACTIVE MATERIALS. (Division of Construction (AEC), Washington, D. C.). Oct 1969. 758p. Dep. GPO $6.00.

The directory is selective and does not list every container in the AEC inventory, but rather lists each container type in the AEC inventory as well as those privately owned containers for which appropriate data have been supplied. The directory was developed primarily to assist container designers and shippers of radioactive and fissile materials. (J.R.D.)

22931 SOLIDIFICATION OF RADIOACTIVE WASTES. Schneider, K. J. (Battelle Memorial Inst., Richland, Wash.). Chem. Eng. Progr.; 66: No. 2, 35-41(Feb 1970).

The conversion of highly radioactive liquid wastes to solids prior to long term storage is desirable because radioactive wastes must be stored for long periods of time and solids remain immobile, are less soluble in water, smaller in volume, and more physically rugged than those stored in liquids. Four processes being developed and tested on engineering scales are pot calcination, spray solidification, phosphate glass solidification, and fluidized bed calcination. The methods and equipment are described. The cost of high-level waste management involving solidification in combination with interim liquid storage, transportation, and final disposal in a salt mine or other disposal technique has been estimated. The characteristics of solidified high-level Purex wastes are tabulated. (J.C.W.)

22932 INCORPORATING INDUSTRIAL WASTES IN INSOLUBLE MEDIA. Blanco, R. E.; Godbee, H. W.; Frederick, E. J. (Oak Ridge National Lab., Tenn.). Chem. Eng. Progr.; 66: No. 2, 51-6(Feb 1970).

Methods, leach rates, and cost considerations for incorporating waste residues in cheap, impervious media such as asphalt or plastics are discussed. A process developed at ORNL for incorporating radioactive aqueous or organic waste residues in asphalt or thermoplastics using both continuous and batch mixing operations is discussed. The process is applicable to typical industrial and urban residues including used rubber tires, sewage, steel mills, and textile mill residues. The high temperature oxidation (Zimpro) process for solids disposal from sewage is also described. (J.C.W.)

22933 HAZARDOUS MATERIALS TRANSPORTATION. McConnaughey, W. E.; Welsh, M. E.; Lakey, R. J.; Goldman, R. M. (Coast Guard, Washington, D. C.). Chem. Eng. Progr.; 66: No. 2, 57-63(Feb 1970).

The International Maritime Dangerous Goods Code combines elements of both the classification theory and the hazard evaluation theory. With the rapid growth in the size and the variety of shipments it is essential that hazards evaluations be based on a good understanding of properties, hazards, and disaster potential. Environmental and water pollution hazards are discussed. The nine basic classifications include explosives, gases, inflammable liquids and solids, oxidizing and toxic substances, radioactive substances, corrosives, and a miscellaneous dangerous substance category. (J.C.W.)

22934 THIRD PARTY LIABILITY AND INSURANCE IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR SUBSTANCES, MONACO SYMPOSIUM, 7th–11th OCTOBER 1968. Paris; Organisation for Economic Co-Operation and Development (1968). 534p. $7.50. (CONF-681080).

Thirty-eight papers were presented at the symposium. A separate abstract was prepared for each of 37 papers. The paper for which no abstract was prepared is concerned with liability for transport of dangerous goods and oil pollution. (J.R.D.)

For abstracts of individual papers see: 22935–22971.

22935 LEGAL SYSTEM APPLICABLE TO THE CARRIAGE OF NUCLEAR MATTER AS IT RESULTS FROM THE PARIS AND VIENNA CONVENTIONS. Stein, R. M. (OECD, Paris). pp 23-39 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th–11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A review is presented which includes information on basic concepts of the Conventions, geographical scope of the Conventions, damage covered by the Conventions, liability of installation operator-in-charge, liability compensation, security liability, periods of limitation, and legal jurisdiction. (J.R.D.)

22936 INTRODUCTION TO PROBLEMS OF THIRD PARTY LIABILITY IN MARITIME LAW. van den Bosch, C. (International Maritime Committee, Antwerp). pp 43-6 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th–11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

The introduction is used to note the complexity of questions to be considered. Recommendations are included that attention be directed to the interdependence between establishments where atomic energy is produced and the maritime carriers of nuclear materials required for this industry. Also, attention should be directed to the hazards attendant on the added risks of carrying nuclear materials. (J.R.D.)

22937 THIRD PARTY LIABILITY AND INSURANCE IN RELATION TO MARITIME CARRIAGE OF NUCLEAR SUBSTANCES. Rembauville-Nicolle, P. (Groupement de Reassurances Maritimes, Paris). pp 47-118 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th–11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Aspects of liability considered in the study include the rules of third party liability in international maritime law, conflicts between the liability rules under international maritime law and under international nuclear law, and gaps in the system due to non-ratification of the conventions by certain governments. (J.R.D.)

22938 THIRD PARTY LIABILITY IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR SUBSTANCES: NOTE ON ENGLISH LAW. Bonassies, P. (Univ., Aix-Marseille, France. International Maritime Committee, Paris). pp 119-25 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th–11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

It is noted that, although the rules of English law may appear to be among those most likely to prove reassuring to a carrier of nuclear substances—in particular insofar as greater provision is made for the application of the special rules of nuclear law—they nevertheless reveal defects and lacunae, which provide full justification for undertaking the drafting of specific international provisions to which it may be expected that the United Kingdom, faithful to its traditions, will wish to be the first to adhere. (auth)

22939 TRANSPORT OF NUCLEAR MATERIALS FOR THE POWER REACTOR FUEL CYCLE. Williams, J. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 129-42 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th–11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

The transport of nuclear materials for the power fuel cycle is growing fast but the numbers of journeys to be undertaken will not be great by comparison with normal cargo movements. The value of material transported is very large because of its intrinsic value and because for each ton of fuel used the material is carried several times. The value of the nuclear material carried will be several times the value of the equivalent coal or oil, insurance premiums will therefore represent a large sum of money. The experience of the UKAEA is that radioactive ma-

terial can be carried perfectly safely as standard cargo provided that the IAEA packaging standards are adhered to. With the standards of packaging the risk arising from the carriage of radioactive materials is probably a good deal less than much of the non-nuclear cargo carried. Nevertheless it is necessary to insure against third party nuclear risk, a form of insurance cover which is required of neither coal nor oil on the high seas. and which arises for non-nuclear material only as third party insurance for road transport vehicles. It is probable that nuclear power is leading the path in standards of insurance as well as of safety and that in the future all shipments will be required to carry some form of third party insurance. (auth)

22940 TECHNICAL PROBLEMS AND SAFETY IN THE MARITIME CARRIAGE OF RADIOACTIVE MATERIAL. Sousselier, Y.; Bouillet, J. (CEA, Paris). pp 143-55 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Results of studies directed mainly toward transport of Pu and irradiated fuels are presented. It is noted that present packaging is very effective and that transfer of nuclear materials is at least as safe as that of many other dangerous materials. (J.R.D.)

22941 THE PRACTICAL POSITION OF NUCLEAR OPERATORS WITH RESPECT TO THIRD PARTY LIABILITY INSURANCE ON THE MARITIME CARRIAGE OF NUCLEAR SUBSTANCES. Lagorce, M. (CEA, Paris). pp 157-62 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Aspects of third party liability coverage are discussed which shipowners and maritime carriers incur under maritime conventions and which they retain by refusing to accept the rule that nuclear conventions should prevail over maritime conventions in matters of third party liability for damage arising out of nuclear incidents occurring in the course of transporting nuclear materials. Specific cases are reported to illustrate the flaws apparent in such rules systems. (J.R.D.)

22942 THE PRACTICAL PROBLEMS FACING SHIPOWNERS IN THE CARRIAGE OF NUCLEAR MATERIALS. Squires, M. (International Chamber of Shipping, London). pp 163-8 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Discussions are included on the value of standardized safety regulations, application of safety regulations, types of nuclear materials and stowage problems, relations with harbor authorities, and insurance coverage of carriers. (J.R.D.)

22943 THE GENERAL CONDITIONS FOR THIRD PARTY LIABILITY INSURANCE FOR THE MARITIME CARRIAGE OF NUCLEAR SUBSTANCES. Lacroix, F. (European Insurance Committee, Brussels). pp 185-90 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A review of conditions related to European markets for insurance of third party liability in shipping nuclear materials is presented. (J.R.D.)

22944 ORGANISATION OF NUCLEAR THIRD PARTY LIABILITY TRANSIT INSURANCE IN THE UNITED KINGDOM. Miles, A. C. (British Insurance (Atomic Energy) Committee, London). pp 191-5 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A third party insurance system is described in which a single public liability issued by a nuclear pool is in effect during transit of nuclear materials. The discussion is related mostly to UK non-government licensees engaged in transport of nuclear materials. (J.R.D.)

22945 SOME LEGAL INTERPRETATIONS WHICH WOULD JUSTIFY THE PRACTICE FOLLOWED BY THE JAPAN ATOMIC ENERGY INSURANCE POOL RBGARDING INSURANCE. Masaki, M. (Japan Atomic Energy Insurance Pool, Tokyo). pp 197-212 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A review of nuclear transport liability insurance in Japan is presented covering nuclear operators, consignors, and consignees. Information is included on early development, in 1961 and later development in 1962 and 1963 when nuclear hazards were established as primarily criticality, radioactivity leakage, fuel or nuclear material meltdown, and bodily overexposure to ionizing radiation. Comment is included concerning opinions of the nuclear insurance pool on legal difficulties arising from various basic principles underlying the Paris and Vienna Conventions. (J.R.D.)

22946 INSURING NUCLEAR MATERIALS SHIPPED TO AND FROM THE UNITED STATES. Rand, A. C. (Marsh and Mc Lennan, Inc., New York). pp 213-18 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

The status of liability insurance for nuclear material shipment to and from the U. S. is reviewed. Information is included on the Nuclear Energy Liability Association, Mutual Atomic Energy Liability Underwriters, and the London marine market as sources of liability insurance. (J.R.D.)

22947 INSURANCE OF DAMAGE DUE TO NUCLEAR INCIDENTS IN THE TERRITORY OF NON-CONTRACTING STATES AND DAMAGE SUFFERED IN SUCH TERRITORY AND INSURANCE OF CONTRACTUAL LIABILITY. Van Gijn, S. H. (Bureau van de Nederlandse Pool voor Verzekering van Atoomrisico's, Rotterdam). pp 219-24 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Solutions to problems associated with liability insurance for transport of nuclear materials in non-contracting states are examined. Results of these considerations indicate that contractual liability in non-contracting states plays an important part, thus insurers must direct their attention to possible damage caused by nuclear material transit in these areas. (J.R.D.)

22948 THE SPECIALIZED CARRIER ACTING AS LIABLE OPERATOR OR SUBSCRIBING THE THIRD PARTY LIABILITY INSURANCE ON CARRIAGE. Deprimoz, J. (French Atomic Risk Insurance Pool, Paris). pp 225-34 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Results of an examination of compensation rules for nuclear incidents in which third party liability is channeled to one individual are presented. Discussions are included on basic enactments of various OECD countries, interests at stake in shift of liability to the individual carrier, special features of carriers, third party liability insurance associated with a shift of liability to the carrier, and insurance stipulated in favor of a third party. (J.R.D.)

22949 LIABILITY AND INSURANCE PROBLEMS FOR DAMAGES TO NUCLEAR SUBSTANCES IN COURSE OF TRANSPORT. Pfeiffer, C. (Deutsche Kernreaktor-Versicherungsgemeinschaft, Cologne). pp 235-9 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

It is noted that third party liability insurers think it is necessary to exclude damage to the nuclear materials themselves from the cover of third party liability during the material transit. In the case of other freight carried it appears reasonable not to call upon the nuclear third party liability insurer except where, under other legal rules, such liability is appropriate. Ways which other freight is treated in relation to liability insurance in various OECD countries are examined. (J.R.D.)

22950 COVER OF DAMAGE TO MEANS OF TRANSPORT. Belser, W. E. (Swiss Atomic Risk Insurance Pool, Zurich). pp 241-54 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Arguments supporting removal of responsibility for damage to nuclear materials transport vehicles from installation operators

are presented. Discussions are included on the initial attitude of third party liability insurers, position of the Convention on exclusion of transport vehicle damage from operator liability, the situation under national laws of various countries and the present position of insurers. (J.R.D.)

22951 SKELETON THIRD PARTY LIABILITY INSURANCE POLICY FOR THE CARRIAGE OF NUCLEAR SUBSTANCES. ESTABLISHED BY THE COMMISSION OF THE EUROPEAN COMMUNITIES, AND ITS PRINCIPAL PROVISIONS CONCERNING NUCLEAR DAMAGE TO THE SHIP AND CARGO. Risch, B. (Commission of the European Communities, Brussels). pp 255-78 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Skeleton third party liability insurance policy for the carriage of nuclear substances

A system of third party liability development is discussed in which the most important factors considered include type of liability, suitable compensation for victims, nature and extent of the insurance risk, and national government participation in cases of large scale damage. An outline of the provisions of the skeleton third party liability insurance policy formulated by the Commission of the European Communities with these factors considered is presented. (J.R.D.)

22952 LIABILITY INSURANCE COVER OF CARRIERS BY SEA OF NUCLEAR MATERIALS. Miller, C. (Thos. R. Miller and Son, London. International Maritime Committee, Antwerp). pp 279-86 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A system of liability coverage for carriers of nuclear materials is described which is based on classes or categories of materials carried. These divisions include U ores and concentrates, radioisotopes, fissile materials, and more radioactive materials such as irradiated fissile materials. (J.R.D.)

22953 INSURANCE OF RADIOACTIVE MATERIALS IN TRANSIT. Stewart, B. A. (Joint Marine Atomic Energy Committee, London). pp 287-90 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A description of liability insurance available in the London market is given. A broad outline of protection is effected by wording. Each declaration, for which there are no standard phrases, is tailor-made to the requirements of the insured by dovetailing existing maritime laws and facts in with the Convention requirements. The London market has the capacity to give liability insurance coverage up to about $14,000,000. (J.R.D.)

22954 MARINE INSURANCE ASPECTS ON THE CARRIAGE OF NUCLEAR SUBSTANCES. von Schlayer, K. F. (Allianz AG, Munich). pp 291-301 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Aspects of marine in-transit insurance for nuclear materials are examined and comment concerning scope of insurance coverage in Germany is offered. Discussions are also included on special policy conditions in respect to coverage of criticality and radioactive contamination risks, methods of calculating insurance requirements for nuclear materials, insurance of effectiveness of shielding and packaging materials, and insurance of carrier ships. (J.R.D.)

22955 GERMAN NUCLEAR ENERGY CLAUSES IN HULL AND CARGO INSURANCE. Moeller, H. (Kernenergie-Studiengesellschaft, Hamburg). pp 303-14 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Discussions dealing with insurance of ships carrying nuclear materials are presented along with similar discussions concerning insurance of non-nuclear cargoes carried in ships also carrying nuclear materials. Information is included on hull insurance, nuclear material cargo insurance, and non-nuclear cargo insurance. (J.R.D.)

22956 THIRD PARTY LIABILITY INSURANCE IN RESPECT OF THE CARRIAGE OF NUCLEAR SUBSTANCES ON THE BASIS OF GERMAN LEGISLATION REGARDING FINANCIAL SECURITY. Mueller, W. (Allianz AG, Munich). pp 315-17 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Experience since 1962 with third party liability insurance for nuclear material carriers as regulated by the German financial security ordinance is reviewed. Based on good performance of the system, suggestions are offered in connection with acceptance of the Paris Convention. (J.R.D.)

22957 SHIPOWNER'S LIABILITY: A NEW APPROACH. Kean, A. (Board of Trade, London). pp 329-37 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

A review of the legal thinking that underlies the approach to shipowner's responsibility reveals that the Paris Convention of 1960 and the Vienna Convention of 1963 which differs from it only in a few points of detail, mark a substantial advance from the inadequate principle of liability for negligence to a more adequate system of absolute liability coupled with compulsory insurance. This places the risk on the nuclear operator, so that the cost of providing insurance falls where it belongs, on the cost of the nuclear operations, leaving nothing to turn on the assessment of the operator's negligence or that of his servants. This is to be welcomed as relieving carriers, who in practice have little or no control over the physical measures required to prevent nuclear incidents, from the need to insure against that kind of liability, though the protection given by the Conventions is by no means complete. (J.R.D.)

22958 MARITIME CARRIAGE OF NUCLEAR MATTER: THE RELATIONSHIP BETWEEN LIABILITY UNDER MARITIME LAW AND UNDER NUCLEAR LAW. Albano, R. (Ente Nazionale per l'Energie Elettrica, Rome). pp 339-62 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

An analysis of laws governing maritime transport of nuclear materials shows that delicate and complex problems arise because of the conflict between the rules of liability under maritime law and those under nuclear law. In order to solve these problems and establish a uniform rule, it will be necessary to encourage appropriate studies and action by the competent international bodies. (J.R.D.)

22959 RELATIONSHIP BETWEEN THE PARIS CONVENTION AND THE GENEVA CONVENTIONS OF 1958. de Azcarraga y Bustamante, J. L.; Corretjer Palomo, L. (Univ., Madrid). pp 363-8 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

The relations between a number of legal texts dealing with questions of international law are reviewed. Information is included on the Convention on Third Party Liability in the Field of Nuclear Energy (Paris Convention), signed in Paris on 29th July 1960, the Convention on the Territorial Sea and the Contiguous Zone, and the Convention on the High Seas (Geneva Conventions), signed in Geneva in June 1958 and drawn up under the auspices of the United Nations for the purpose of establishing a Law of the Seas consisting of a number of distinct conventions concerning sea transport of nuclear materials. (J.R.D.)

22960 MARITIME CARRIAGE OF NUCLEAR MATERIALS AND THE LIABILITY OF THE STATE UNDER ITALIAN LAW. Marchetti, D. (Ministry of Industry, Commerce, and Handicrafts, Rome). pp 369-75 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

Analyses are presented to show that under Italian law, liability for nuclear damage falls as a general rule upon the operator and that, in the case of carriage, the carrier is liable in place of the operator only if, and to the extent that, he provides the same guarantees as are required of the operator. The carrier is therefore

a person liable only in certain eventualities, and his liability is substituted for that of the operator in a secondary and contingent manner. (J.R.D.)

22961 POLICIES OF THE UNITED STATES ATOMIC ENERGY COMMISSION RESPECTING LIABILITY FOR THE OCEAN TRANSPORT OF NUCLEAR MATERIAL. Spingarn, E. E. (Atomic Energy Commission, Washington, D. C.). pp 377-84 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

A review of policies and laws associated with marine transport of nuclear materials by the U. S. is presented. (J.R.D.)

22962 PROTECTION OF CARRIERS IN RELATION TO THIRD PARTY LIABILITY FOR NUCLEAR DAMAGE: PROVISIONS OF UNITED KINGDOM LEGISLATION. Fitzsimmons, W. E. (Ministry of Power, London). pp 385-90 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

In legislation implementing conventions on third party liability in the field of nuclear energy, the United Kingdom has exercised options open to it under international rules in a manner favorable to carriers. Discussions are included on the legal position of nuclear material carriers and other aspects of protection related to U. K. laws and the Paris Convention. (J.R.D.)

22963 THE SUBSTITUTION OF THE CARRIER'S LIABILITY FOR THAT OF THE NUCLEAR OPERATOR UNDER THE PARIS AND VIENNA CONVENTIONS, AND ITS LIMITS. Vial, G.; Demoures, Y. (CEA, Paris). pp 391-8 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

A survey of the conditions under which the carrier may be liable under the Paris and Vienna Conventions and his obligations in event of such liability is described. The conventions provide that the liability transfer is optional, that at least three people are required for every transport operation, that liability substitution is limited, and that two systems of liability may co-exist. (J.R.D.)

22964 SOME THIRD PARTY LIABILITY PROBLEMS CONFRONTING OPERATORS OF NUCLEAR INSTALLATIONS. French, D. A. (United Kingdom Atomic Energy Authority, London). pp 399-408 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

Results of case studies show that indemnity and insurance problems will arise for nuclear operators from Contracting States particularly when their consignments are to go into the territorial limits of non-Contracting States. In general, journeys in the reverse directions to those chosen for the case studies would give rise to similar problems. Case study results also show that operators from non-Contracting States may encounter formidable insurance and indemnity problems when arranging consignments to other non-Contracting States, unless they have the backing of governmental financial resources. (J.R.D.)

22965 LEGAL RELATIONSHIPS WHICH MAY ARISE UNDER THE PARIS CONVENTION BETWEEN CONTRACTING STATES AND NON-CONTRACTING STATES AS A RESULT OF NUCLEAR INCIDENTS OCCURRING ON THE HIGH SEAS. Hardenne, N. (Ministry for Economic Affairs, Brussels). pp 409-19 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

It is felt that the common interest of the nuclear industry and the associated industries such as insurance and transport requires that precise rules should be laid down to limit with the utmost precision the scope of application of the Paris Convention. For this purpose solutions were proposed which limit the territorial application of the Convention in accordance with the criteria designated by Article 2 of the Convention itself (place of the nuclear incident, place where the damage is sustained) as well as of the general principles of public international law (the relative effects of Conventions, territoriality of ships). It is desirable that Contracting States take these solutions into account and should endeavor by the concerted and effective use of the faculty conferred by Article 2 to arrive at the universal application of the Paris Convention. (J.R.D.)

22966 PROBLEMS RELATING TO APPLICATION ON THE HIGH SEAS OF INTERNATIONAL CONVENTIONS ON THIRD PARTY LIABILITY IN THE FIELD OF NUCLEAR ENERGY. Vandenabeele, F. (Groupement Professionnel de l'Industrie Nucleaire, Anvers, Belgium). pp 421-6 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

The effects of the articles in the Paris Conventions which state that the plant operator's liability extends to damage caused by nuclear incidents during the transport of nuclear material are examined. (J.R.D.)

22967 LEGAL CONFLICTS ARISING FROM THE SIMULTANEOUS APPLICATION OF THE PARIS AND VIENNA CONVENTIONS WITH REGARD TO NUCLEAR INCIDENTS IN THE COURSE OF CARRIAGE OF NUCLEAR SUBSTANCES. Nordenson, U. K. (Swedish Ministry of Justice, Stockholm). pp 427-42 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

Conflicts arising from the existence of four international conventions on third party liability in the field of nuclear energy are examined. Analysis of the rules of these conventions reveals that legal techniques can be evolved to settle the conflicts. It is felt that legal machinery should be set up to effect a water-tight system of nuclear damage compensation on a worldwide basis. (J.R.D.)

22968 COMPENSATING DAMAGE CAUSED TO THE SHIP CARRYING NUCLEAR SUBSTANCES. Warot, J. (French Maritime Law Association, Paris). pp 443-7 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

Arguments in favor of liability for transport of nuclear materials to be assigned solely to the nuclear plant operator are presented. The arguments are supported by examination and rejection of objections formulated against such assignment. (J.R.D.)

22969 LIABILITY AND INSURANCE COVERAGE OF THE SHIPPER OF NUCLEAR SUBSTANCES FOR DAMAGES TO THE CARRYING SHIP. Timm, U. E. (Nuklear-Chemie und-Metallurgie GmbH, Wolfgang, Ger.). pp 449-64 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

Various methods of liability coverage for the shipper are examined and it is concluded that the best procedure is the complete exclusion of damage to the means of transport from the operator's or consignor's liability as proposed by the Paris Convention itself. This solution has the advantage of offering the most clear and logical legal situation and an economic way to solve the problem at the same time. The risk of the carrier could be covered by one insurance only, and the operator would pay the corresponding premium only once. The carrier would have complete protection, even if damage were due partly to his own negligence. Such solution should, therefore, completely correspond to the common interest of all partners in the nuclear field, to facilitate the harmonization of the applicable legal system and to get cost down in this field in order to make nuclear energy competitive. (J.R.D.)

22970 ANALYSIS OF THE MAJOR PROBLEMS ARISING IN MARITIME CARRIAGE OF NUCLEAR SUBSTANCES. Strohl, P. (OECD, Paris). pp 465-73 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances, Monaco Symposium, 7th-11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).
See CONF-681080.

Three of the most important aspects of maritime transport of nuclear materials are examined. Discussions are included on the application of maritime conventions, territorial application limits of the nuclear conventions, and damage to the ship. (J.R.D.)

22971 THIRD PARTY LIABILITY AND INSURANCE IN THE FIELD OF MARITIME CARRIAGE OF NUCLEAR SUBSTANCES. Du Pontavice, E. (Faculte de Droit et des Sciences Economiques, Nantes, France). pp 487-500 of Third Party Liability and Insurance in the Field of Maritime Carriage of Nuclear Substances,

Monaco Symposium, 7th–11th October 1968. Paris; Organisation for Economic Co-Operation and Development (1968).

See CONF-681080.

An analysis of problems associated with transport of nuclear materials between two ports is presented. Provisions of the Paris Convention including the Additional Protocol, Paris are examined from the standpoint of the shipowners. It is felt that these provisions are suspect because their restricted territorial scope and their restricted scope with regard to nuclear material, nuclear installations, and damage. (J.R.D.)

22972 USE AND DISPOSAL OF WASTES. J. Power Div., Amer. Soc. Civil Eng.; 96: 230-42(Feb 1970).

From Conference on Research Needs in Civil Engineering Aspects of Power, Pullman, Wash. See CONF-680907.

The management problems of solid wastes from fossil-fueled electric power generation (fly ash), all types of waste products from nuclear generation, and the possibility of incinerating municipal waste materials for power generation are discussed. Research programs for solving these problems are recommended. (L.C.L.)

22973 AIR CARRIER LIABILITY FOR NUCLEAR DAMAGE. Bailey, Edwin O. (International Air Transport Ass., Montreal). J. Air Law Commer.; 34: 524-52(Autumn 1968).

The legal principles which should be adopted to regulate and assign responsibility for nuclear damage resulting from the carriage of nuclear weapons by air carriers are examined. The international agreements already in existence are discussed, and it is shown that significant areas of conflict exist between these and contemplated treaties governing air carrier liability; e.g., the Warsaw convention and the draft Collisions Convention. It is proposed that the basic design and scope of the legal regimes which should be created by the various provisions of the conventions governing air carrier liability should be predicated on two objectives: protecting the nuclear energy industry from liability which it is not able to assume financially and providing realistic financial indemnity to the public for loss due to a nuclear incident. The operators and operations affected by the conventions are legally defined, and a theory of liability is expounded, which includes the consideration of minimum and maximum limitations of liability, duration of a statute of limitations, delineation of jurisdiction, available recourse actions of the various parties, evidence of financial security, and a discussion of the legal implications of the concept of causation. (IAA)

22974 IMPROVEMENTS IN MONO-RAIL CONVEYOR SYSTEMS. James, Brian Clifford (to H. S. Marsh Nuclear Energy Ltd.). British Patent 1,181,451. 18 Feb 1970. Filed 3 Mar 1967.

Reference is made to monorail conveyor systems of the kind comprising at least one trolley suspended from a rail of I or inverted T section with wheels running on the bottom flanges. It is sometimes desired that such a conveyor shall turn through sharp curves, such as when traversing products across a radiation source within the confines of a biological shield. A conveyor system is described for bearing goods to be irradiated along a zigzag path, to and fro across the radiation source, within a biological shield. A zigzag rail is employed, made up of straight or large radius curved portions, interconnected by portions of small radius; the rail has an upright web with bottom running flanges on each side. The trolley has two pairs of wheels, one pair behind the other, the wheels of each pair being on a common axis extending between the arms of a U-member carrying the wheels, and the two U-members are attached at their bases to a load carrying plate or frame which has freedom for pivotal movement about parallel axis perpendicular to the wheel axes and passes through the bases of the U-members, and bisecting the wheel axes, so that the trolley may travel along the rail on a zigzag path, with the two wheels of each pair running on the rail flanges. The pivotal freedom of the U-members permits the trolley to negotiate the curved portions of small radius. The straight or large radius rail portions are preferably constructed of rolled I-section joist and each small radius portion is separately constructed of I-section or inverted T-section and connects two portions of I-section joist, with the bottom flanges providing a continuation of the bottom flanges of each portion of I-section joist. The wheels preferably have flanges running against the edges of the running flanges of the rail. The wheel flanges should preferably be chamfered or tapered on the sides adjacent to the rail, in order to provide clearance on bends. (UK)

22975 REGULATORY CONTROLS ON RADIOACTIVE EFFLUENTS. McBride, J. A. (Atomic Energy Commission, Washington, D. C.). Chem. Eng. Progr.; 66: No. 4, 74-7(Apr. 1970).

The control of radioactivity releases to the environment, the regulations governing their release, and experience to date with the release of radioactive effluents are discussed. Nuclear fuel reprocessing plant waste handling procedures are used as an example of how chemical engineering principles can be applied to the control of environmental contamination. (L.C.L.)

22976 ULTIMATE MANAGEMENT OF RADIOACTIVE LIQUID WASTES. Slansky, Cyril M.; Buckham, James A. (Idaho Nuclear Corp., Idaho Falls). Chem. Eng. Progr., Symp. Ser.; 65: No. 97, 26-31(1969).

It is very possible that in the next 30 yr an ultimate disposal process for radioactive waste from nuclear power will be developed. Such a process would truly eliminate the radioactive components from man's environment. As an alternate, an ultimate method for the storage of either liquid or solid high level fission product waste will be needed. The latter process will depend on extensive research and development into the movement of waste stored in the ocean trenches or in underground caverns. As an interim measure, waste must be stored under safe conditions with a minimum of additives, economically, and such that it can be readily retrieved for eventual conversion by the ultimate process. The large inventory of short-lived fission products may justify development of processes to reduce their potential hazard. Our high level wastes should be held in this interim condition pending the development of ultimate management. There will be considerable need to define the safety and economic aspects of on-site interim storage vs the transportation of the wastes to a few central storage and disposal depots. (auth)

22977 FORESIGHT IN WASTE MANAGEMENT. Int. At. Energy Agency Bull.; 12: No. 1, 30-4(1970).

Methods used for the handling and storage of all types and levels of radioactive wastes from the nuclear industry are outlined. Suggestions are made for making use of developing technology and knowledge to remove all possibility of harmful effects to the environment. (L.C.L.)

22978 PACKAGING AND STORING RADIOACTIVE WASTES. LaRiviere, J. R. (Atlantic Richfield Hanford Co., Richland, Wash.). Chem. Eng. Progr.; 66: 42-4(Feb 1970).

The packaging and storage facility for ^{90}Sr and ^{137}Cs radioactive wastes at Hanford is described. The new facility includes the hot cell and a capsule storage facility. Two process operations will be performed in the new facility; namely, the strontium fluoride conversion and packaging process and the cesium chloride conversion and packaging process. The design of the facility is oriented towards the maximum protection of personnel, the environment, and the equipment. (J.C.W.)

Vacuum Engineering

Refer also to abstracts 23481–23484 and 23935.

22979 ION DESORPTION BY ELECTRON BOMBARDMENT: RELATION TO TOTAL AND PARTIAL PRESSURE MEASUREMENT. Redhead, P. A. (National Research Council, Ottawa). J. Vac. Sci. Technol.; 7: 182-7(Jan-Feb 1970).

From 16th National Vacuum Symposium, Seattle, Wash. See CONF-691006.

When electrons strike certain adsorbed gases, positive ions, neutrals, and/or excited neutrals are released. This electron impact desorption (E.I.D.) effect can cause significant errors in total pressure measurement with hot-cathode gages and can change the striking characteristics of magnetic, cold-cathode gages. In certain mass spectrometers, "surface ion" peaks appear in the mass spectrum resulting from E.I.D. of gases sorbed at the ion source electrodes. The general characteristics of E.I.D. and the results of measurements of E.I.D. from metal surfaces are briefly reviewed. The effects of E.I.D. on the characteristics of hot- and cold-cathode gages and mass spectrometers are considered in some detail. Methods of minimizing errors caused by E.I.D. are discussed. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 22574.

General Detectors and Monitors

Refer also to abstracts 22599, 23023, 23208, 24460, 24482, and 24705.

22980 (AAEC/TM–527) GAMMA-RAY COMPENSATED GERMANIUM DETECTORS. Lawson, E. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1969. 14p. Dep. CFSTI (U. S. Sales Only).

Low resistivity p^+ and n^+ contacts are formed on high purity n-type Ge. A $p^+ - i - n^+$ structure is formed on irradiation with ^{60}Co γ-rays. When used as a γ-ray spectrometer, resolutions (FWHM) of 8 keV at 662 keV and 6 keV at 122 keV have been achieved. Details are given of the preparation and the characteristics of such spectrometers. The stability of the radiation defects enables the spectrometers to be stored at room temperature. Detector resolution and efficiency and the procedure for forming contacts are discussed briefly. (auth) (Australia)

22981 (BNWL-SA–1947) EVALUATION PROGRAM FOR PORTABLE RADIATION MONITORING INSTRUMENTS. Zuerner, L. V.; Kathren, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1968. Contract AT(45-1)-1830. 23p. (CONF-690103–20). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

A well oriented and directed evaluation program for radiological measuring devices for health physics purposes should examine appropriate physical, electronic, and radiological characteristics of the instrument, providing data for performance and cost analysis. For portable instruments, weight, strength, and ease of handling and servicing are important physical characteristics. Human engineering features such as ease of meter reading, availability of controls, and physical stability must also be considered. Among the electronic features to be considered are sensitivity, temperature and voltage dependence, stability, battery lifetime, response to electrical interference, noise and vibration, and extracameral radiation. Radiological factors include accuracy and stability of calibration, energy dependence, response to unwanted radiations, temperature dependence, and saturation effects. A typical evaluation program is outlined for portable radiation survey meters and recommendations made for a standardized system of determining and reporting instrument performance. (auth)

22982 (CEA-CONF–1420) CONCEPTION OF PROTECTION IN INSTALLATIONS SUBJECT TO HAZARD OF CRITICALITY. TEST OF ACTIVE MATERIALS NEAR A SOURCE REPRODUCING A REAL ACCIDENT. Benezech, G.; Gey, A.; Renard, C. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Lecorche, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 15p. (In French). (SM–125/10; CONF-691008–4). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of Hot Facilities, Saclay, France.

The concept of protection in installations subject to criticality hazards is outlined with a consideration of the general philosophy, equipment criteria, possible evolution of the philosophy, and detection and alarm-criticality networks. The types of detectors and the processing of the data received from them are summarized. Tests made on real detection materials near a source reproducing real accidents are reported. Two possible solutions to the inadequacies of the present coincidence system are proposed. (J.S.R.)

22983 (CEA-N–1281) CONNECTIONS TO BE USED BETWEEN PRINCIPAL DETECTORS OF IONIZING RADIATIONS AND THEIR ELECTRONIC INSTRUMENTS. Lefevre, Roger; Roquefort, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 40p. (In French). Dep. CFSTI (U. S. Sales Only).

The most important input and output connections, connectors and cables that link detectors of ionizing radiation with their associated electronic instruments are described. As a guide for the user, a list of standard connectors and cables for every kind of instruments is given. Preferred connections to be used for each particular case are indicated. In addition, several examples of connections between detectors and apparatus, connector types and their associated cables, and various configurations of ground and earth circuits are given. (France)

22984 (FOA–4–4417) METHODS FOR AUTORADIOGRAPHIC EXAMINATION OF SMALL RADIOACTIVE PARTICLES. Sisefsky, J. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar 1970. 64p. Dep. CFSTI (U. S. Sales Only).

When a prepared sample of small radioactive particles (such as nuclear debris) is autoradiographed, the images are produced by radiation penetrating out from the particles into the surrounding emulsion, giving rise to circular spot images, the sizes of which depend on the intensity of the radiation. This fact is exploited for identifying active particles among inactive ones, by a method in which the particles are prepared on a transparent support, which is then permanently covered with photographic emulsion. After exposure the emulsion is developed in such a way that the circular spots turn transparent and unstained against a translucent or transparently colored background. (Reversal autoradiography.) The active particles thus turn visible under the microscope and are identified by being situated in the very centers of the clear spots. Their activities can be measured from the sizes of these spots. How active particles, collected on filters, are prepared on transparent supports is described, and how this preparation is coated with emulsion, exposed, and processed is discussed. The spot size versus activity is discussed from theoretical and practical viewpoints (also for conventionally developed autoradiograms). Various sources of error are discussed, especially the case when the particles are so large compared with the spots that they cannot be considered as point sources. (auth)

22985 (INR-P–1161) COAXIAL GERMANIUM DETECTORS OF γ RADIATION. Khvashchevska, Ya.; Yurkovski, Ya.; Shimchak, M.; Skochek, K. (Joint Institute of Nuclear Research, Warsaw (Poland)). 1969. 14p. (In Russian). Dep. CFSTI. (U. S. Sales Only).

Coaxial Ge(Li) detectors having active volumes of 2 to 10 cm^3 and resolutions of 1.9 keV for 122 keV gamma radiation (^{57}Co) and 2.7 keV for 662 keV gamma radiation (^{137}Cs) were fabricated. Preamplifiers for these detectors and the vacuum chamber for the operation at low temperatures (N_2) have been constructed. (auth)

22986 (NP–18177) DESIGN AND CONSTRUCTION OF AN AMPLIFIER FOR SIGNALS ORIGINATING IN A GAS IONIZATION DETECTOR. Martinez Robles, Jose Luis (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Ingenieria Mecanica y Electrica). 1969. 48p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The characteristics of the principal gas ionization detectors including ionization chambers, proportional counters, and G-M detectors are outlined. The conditions which an amplifier to be used with these detectors must satisfy are considered from the viewpoint of the pulse-height analyzer, input circuit, linearity of the amplifier, noise, simple RC differentiation, and accumulation and superposition effects. The design of an amplifier is described in detail with a description of the separator stage, amplifier stage, adjustment stage, differentiator circuit, and polarization circuit of the detector. The experimental results on the characteristics of the amplifier constructed are reported and show that the amplifier is suitable for amplification of signals originating in a gas ionization chamber. (J.S.R.)

22987 (NP–18180) DEVELOPMENT OF LITHIUM-ACTIVATED GERMANIUM SEMICONDUCTOR NUCLEAR DETECTORS. Gallardo Villegas, Raul (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1970. 72p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The construction of coplanar lithium-drifted germanium detectors is presented. The interaction of nuclear radiation with matter, which is necessary in order to understand the functioning of semiconductors, is discussed. The properties and the theory of semiconductors necessary for detectors and the properties of the diffusion mechanism used to obtain ions in an n-p junction are considered. The operation and some uses of various types of detectors are treated in a general form, and the advantages and disadvantages of Li-drifted Ge detectors are given. The technique used in the construction of Ge(Li) detectors is presented, and the results obtained in the manufacture of these detectors are given. (tr-auth)

22988 (NP–18183) THE CRITICALITY ALARM SYSTEM EMPLOYED AT THE EUROCHEMIC REPROCESSING PLANT. Hunzinger, W. (European Company for the Chemical Process-

ing of Irradiated Fuels, Mol (Belgium)). Sep 1969. 19p. (ETR-248). Dep. CFSTI (U. S. Sales Only).

If a critical excursion of fissile material occurs, the criticality alarm system will give an alarm in the endangered areas, thereby making the evacuation of these areas possible. Two different types of criticality alarm system are installed at EUROCHEMIC, the choice between the types depending on local circumstances. One type detects neutrons from the excursion by a beta-current detector connected to a dc amplifier. The entire system is designed according to the life-zero technique, electronically reliable with respect to both safe and un-safe failures. Its detection limit is better than 2 10^9 n/cm^2. The other type is sensitive to gamma-rays and employs ion chambers directly coupled to an electrostatic relay. It uses three ion chambers connected to a 2 out of 3 matrix composed of electromagnetic relays. The detection limit is better than 50 mR. A built-in recharging circuit recharges all three ion chambers when the charge of one chamber has dropped to 20 mR thus permitting the use of these criticality alarm systems independently of the gamma-background radiation up to an exposure rate of 1500 mR/h. The designs of both types of criticality alarm system are given and the criteria on which their choice is based are discussed. (auth)

22989 (ORNL-TM-2885) A NEW SURGICAL PROBE FOR THYROID-CANCER OPERATIONS (AND OTHER APPLICATIONS). Ross, D. A.; Dyer, G. R.; Zucker, A.; Goodman, C. D.; Halbert, M. L.; Newman, E.; Olson, E. L. (Oak Ridge National Lab., Tenn.). Apr 1970. 14p. Dep. CFSTI.

The surgical probe, developed at the Oak Ridge National Laboratory in the mid fifties, includes a sterilizable, hand-held scintillation detector that can be used, during a surgical operation, to search for small fragments of radioactive tissue. The device has been particularly useful for the removal of metastases from a thyroid cancer following an earlier, and not wholly successful, operation aimed at total extirpation. The metastases must, of course, concentrate radioiodine at least to some extent, but many of them do this after the normal thyroid tissue has been taken out. The 1956 probe was designed for use with iodine-131, whose radiation is sufficiently penetrating to cause problems in regard to both shielding and detector efficiency. Nevertheless, the device undoubtedly saved a number of lives. The prospects changed for the better with the advent of iodine-125. Its chief radiation (a 27½-keV x ray) has a half-layer of only an inch or so in watery media, so that the general body background should be heavily self-absorbed. Radiation from a metastasis, on the other hand, should have little difficulty reaching a detector only a couple of centimeters away. The thallium-activated cesium iodide crystal, necessarily small, should perform much more efficiently at the lower energy, and its collimating shield could be thinner. An additional consideration suggesting a revised model was the advent of reliable, solid-state circuitry that promised to minimize heat-dissipation problems. (auth)

22990 (UCRL-50745) INSTRUMENTATION FOR THE OSO-IV CHARGED PARTICLE EXPERIMENT. Waggoner, James A.; Held, James L.; Higley, Wayne R.; Peters, Donald C. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Sep 1969. 62p. Dep. CFSTI.

An instrument was designed, developed, constructed, tested, and calibrated for the investigation of the energy spectra and angular distributions of protons and electrons in the earth's magnetosphere from the OSO-IV satellite. The 33.3-lb instrument consisted of a single scintillator-photomultiplier assembly and associated electronics for identifying the type of incident radiation and its energy and angular distribution. Particle identification was accomplished by pulse-shape discrimination of the pulses produced by the stilbene scintillator. Differential energy spectra were accumulated in eight energy intervals for each particle type. Angular distributions were obtained in 16 intervals of 22.5° each. Correlation of these angular distributions with the local magnetic field was made by utilizing a single-axis magnetometer incorporated in the satellite. A detailed description of the instrument, the principle of operation, selected circuit diagrams, testing, and calibration procedures are presented. The instrument was launched October 18, 1967, and is still in operation at the time of this report. Orbital parameters of the satellite are a nearly circular orbit at an altitude of approximately 550 km, an inclination of 33° with respect to the equatorial plane, and an orbital period of 95.77 min. The satellite is spin stabilized at a nominal 30 revolutions per min. (auth)

22991 (UCRL-72109) SPECTRUM DEGRADATION EFFECTS IN Ge(Li) DETECTORS. Armantrout, G. A. (California Univ., Livermore. Lawrence Radiation Lab.); Thompson, H. W. Jr. (Purdue Univ., Lafayette, Ind.). Mar 1970. 24p. (CONF-700301-6). Dep. CFSTI.

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The mechanisms responsible for the degradation of the performance of Ge(Li) detectors (which include the effects of uniform trapping, non-uniform trap distribution, and locally weak collection fields) are considered, and simulated spectra have been computed. Experimental measurements have been made to identify these sources of degradation. The important results include a measurement of the effective capture cross sections of the most important traps and a determination of the main sources of non-uniform trap distribution and weak collection fields in Ge(Li) detectors. (auth)

22992 FORMULA FOR THE VARIANCE OF A RATEMETER TRACE. Goss, S. G. (Radiological Protection Service, Sutton, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 179-80(Mar 1970).

Reference is made to an expression for estimating the variance of the output from a Bradley–Marks correlation rate-meter when used to measure stationary backgrounds (Edwards Internat. J. Appl. Radiat. Isotop. 20: 569(1969)). A better estimate of the variance, which might also be of value in the interpretation of ratemeter charts, is derived. (UK)

22993 SYSTEMS FOR MONITORING AND EVALUATION OF THE DOSE OF RADIOACTIVE SUBSTANCES IN THE PULMONARY CIRCULATION. Cellerino, A.; Catolla Cavalcanti, R.; Gaetini, A.; Banaudi, C. (Univ., Turin). G. Fis. Sanit. Prot. Radiaz.; 12: 35-8(1968). (In Italian).

Both in the clinical physiological field (diagnostic) and from the viewpoint of protection, the intrapulmonary distribution (ventilatory and circulatory) of radioisotopes introduced by way of the pulmonary circulation appears to be of great interest. Monitoring allows the problem to be approached not only from the qualitative point of view (pulmonary scintiscanning) but also semiquantitatively. For calibration it is useful to refer to lung models of equivalent tissue, from which the influence exerted by the thickness of the absorption walls and pulmonary volume on the experimental counting values can be calculated. For radionuclides with beta ray emission, the study of the intrapulmonary distribution offers no topographical points of reference: with appropriate systems of continuous monitoring of the airflow, however, it is possible to calculate the distribution in the different pulmonary compartments of differential air exchange. (Excerpta Med.)

22994 IMPROVEMENTS IN OR RELATING TO PULSE IONISATION CHAMBERS. Goodings, Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,183,718. 11 Mar 1970. Filed 18 May 1966.

Reference is made to gas filled pulse ionization chambers of the fission chamber type, such as are extensively used in nuclear reactor control systems. Such an instrument will normally cover only a limited range of neutron flux levels. In order to improve performance, a filling gas comprising a mixture of a rare gas, for example argon, and a polyatomic gas such as CO_2 or CH_4 has been proposed; in this way it is possible to increase the electron drift velocity to give faster collection times. Such a filling mixture, however, suffers from the disadvantage that it is liable to radiation damage in high neutron fluxes, with consequent change in drift velocity characteristics. By judicious selection of a second rare gas as additive in suitable proportion, a fast collection time may be achieved and the possibility of radiation damage avoided. The fission chamber is preferably filled with a gas mixture which includes He and Xe. The particular mixture to be used depends partly on its ability to arrest fission fragments originating from fission of the chamber coating and thereby retain the energy of the fission fragments in the filling gas, and partly on the desired electron drift velocity. Xe is probably the best gas from the point of view of stopping power, having the highest mass number; Kr and Ar are less suitable, and Ne is liable to electrical breakdown. In tests it was found that a filling comprising He and a 25% addition of Xe gave the fastest collection time (about half that observed with an Ar filled chamber under similar conditions). The optimum proportions are easily discernable from observations made with different mixtures. Alternative fillings are He + Kr and He + Ar.(UK)

22995 SEMI-CONDUCTOR DOSIMETER. (to Battelle Development Corp.). British Patent 1,185,377. 25 Mar 1970. Priority date 13 Jun 1966, United States.

Fabrication, properties, and performance of a lithium-diffused p–n junction silicon detector for fast neutron dosimetry are described. (W.H.K.)

22996 PARTICULARS OF THE ZONAL CHARACTERISTICS OF A GAMMA-RAY DETECTOR INTENDED FOR ACTIVATION MEASUREMENTS OF REACTOR PARAMETERS. Bushuev, A. V.; Yurova, L. N. At. Energ. (USSR); 27: 458-9(Nov 1969). (In Russian).

Radioactive nuclei are not homogeneously distributed in a foil which has been exposed in a reactor. The measurement results however can be interpreted in a definite way if the count rate is directly proportional to the amount of reaction product in the foil. This condition will be fulfilled if the detecting system picks up with equal efficiency the radiation emitted in any element of the sample volume. One method of doing this is to place the sample next to the surface of the detector in a zone of constant sensitivity. The introduction of a light guide between the NaI scintillator and the photocathode of a photomultiplying tube can improve the evenness of sensitivity along the surface of the detector (zonal characteristic). With a plexiglas light guide 10 mm high it was found that the counting efficiency of the above system for 74 keV radiation from ^{239}U was greater than 99%, while the probability of counting hard background radiation was low. (TTT)

22997 DOSE SENSITIVITY OF NEUTRON TRACK DETECTORS. Obaturov, G. M. At. Energ. (USSR); 27: 470-4(Nov 1969). (In Russian).

Dose sensitivities for the detection of neutron tracks in materials such as mica, glass and plastic were determined in detectors containing layers of ^{237}Np, ^{238}U (depleted by a factor of 230), natural uranium and ^{235}U (90% enrichment) for 12 different reactor neutron spectra and for monoenergetic neutrons varying in energy from 0.5 eV to 10 MeV. The dose sensitivity is given in tracks per rad-cm^2 for these detectors. The dose sensitivity of all detectors strongly depends on the neutron energy, but for ^{238}U, natural uranium and neutrons with energies above 1.5 MeV, and for ^{237}Np with neutrons having energies above 0.6 MeV, the dose sensitivity varies slightly and lies within the limits of 1.38 to 1.93×10^2, and 3.34 to 5.93×10^2 tracks/rad-cm^2 with maximum deviations of ±16 and ±28% respectively from the average. Values of the dose sensitivity are tabulated for the above detectors for neutron spectra varying from soft to hard, depending on the material that would be used to shield the neutrons. (TTT)

22998 CONDITIONS OF OPERATION OF SELF-QUENCHING G-M COUNTERS DEPENDING ON THE ELECTRODE DIAMETERS. Peeva, A.; Karatoteva, T. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci.; 22: 1357-60(1969).

The influence of the anode and cathode diameters of self-quenching G-M counters on their operating properties was studied. The characteristics of the G-M counter were studied for various anode and cathode diameters over a wide temperature range. (W.H.K.)

22999 SCINTILLATION ANISOTROPY OF ANTHRACENE CRYSTALS BOMBARDED BY α PARTICLES IN THE ENERGY RANGE 1 TO 3 MeV. Kratochwill, Franz-Josef (Univ., Goettingen, Ger.). Z. Phys.; 234: 74-81(1970). (In German).

Anthracene crystals were bombarded by α-particles of variable energy. The total luminescence and the scintillation anisotropy were measured as a function of α-particle energy. In the energy range 1 to 9 MeV the scintillation anisotropy is found to be an almost linear function of α-energy. The results are compared with those obtained from Kienzles theory of anisotropy and Voltz' theory of specific luminescence. It is shown that the experimental results cannot be explained by assuming only the quenching parameter to be anisotropic. (auth)

23000 CIRCUIT ARRANGEMENT FOR DIGITALIZING AN ANALOG VALUE. Colombo, Gianni (to European Atomic Energy Community). British Patent 1,178,599. 21 Jan 1970. Priority date 9 Nov 1966, Italy.

An analog-to-digital pulse converter circuit is described. The circuit employs a pulse shaper, a voltage-to-frequency converter adapted to provide output pulses at a frequency determined by voltage, and a digital counter. The shaper produces a voltage pulse of invariable duration whose time integral is proportional to the analog value, and the pulses from the voltage-to-frequency converter go to the counter which counts the pulses during a fixed time. (W.H.K.)

23001 APPARATUS FOR THE COLLECTION AND LOGARITHMIC MEASUREMENT OF QUANTITIES OF CHARGES PRODUCED BY AN IONIZATION CHAMBER. Burkhart, Andre; Guillot, Francois (to Commissariat a l'Energie Atomique). British Patent 1,180,259. 4 Feb 1970. Priority date 13 Dec 1966, France.

An apparatus for the collection and logarithmic measurement of quantities of charges produced by an ionization chamber is described. The apparatus is characterized in that it is constituted on the one hand by a charge adaptor comprising a collection capacitor having negligible leakage which is charged by the ionization chamber and a device for following at high impedance the exponential discharge of said capacitor into a resistor down to a predetermined level and on the other hand by measuring instrument proper which serves to determine the time-duration of discharge and comprises a trigger circuit arranged to be actuated during the period from the commencement of the discharge until a threshold voltage is reached, a sawtooth generator controlled in dependence on said trigger circuit and adapted to produce a voltage rising linearly with time during the time of actuation of said trigger circuit, a memory circuit receiving said sawtooth voltage and a logarmithmic-scale galvanometer which is controlled by said memory circuit. (auth)

23002 AUTOMATIC MONITORING SYSTEM. (to Ateliers de Montage Electriques). British Patent 1,187,541. 8 Apr 1970. Priority date 20 Jan 1967, France.

An automatic air sampler is described which periodically samples the dust particles in the air using a pump system and filter paper and counts the radioactivity with a radiation detector. When the preset radioactivity threshold level is measured, an alarm circuit is triggered. (W.H.K.)

23003 DUAL-SPECTROMETER SYSTEM FOR HIGH-EFFICIENCY IMAGING OF MULTI-GAMMA-EMITTING NUCLIDES WITH THE ANGER GAMMA CAMERA. Goodwin, D. A.; Menzimer, D.; DelCastilho, R. (Veterans Administration Hospital, Palo Alto, Calif. Stanford Univ., Palo Alto, Calif.). J. Nucl. Med.; 11: 221-3(May 1970).

A dual-spectrometer version of the Anger camera is described which increases the detection efficiency by 40 to 60%. This system is useful for low-level multi-energy gamma emitters which are necessarily used in studies that require longer periods of observation. (W.H.K.)

23004 IMPROVEMENTS IN AND RELATING TO A DETECTION APPARATUS. Guillon, Henri; Levy, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,186,597. 2 Apr 1970. Priority date 9 Jun 1966, France.

A radiation detector circuit for a pulse-type detector is described which provides both time information and energy information for the detected particles. The energy information is derived from pulse-height analysis. (W.H.K.)

23005 SUCCESSIVE TRANSFORMATIONS OF RENEWAL PROCESSES THROUGH NUCLEAR COUNTERS WITH DEAD-TIME. Bergamaschini, M. E.; Manfredi, P. F.; Maranesi, P. (CESNEF-Politecnico, Milan). Energ. Nucl. (Milan); 17: 249-55(Apr 1970).

A review of the general theory of counting processes is given, and a formulation is introduced which seems the most suitable to describe the behavior of counters with constant dead-time for a given input process of renewal nature. Particularly the statistic behavior of a cascade of two counters is, in an homogeneous way, analyzed and determined under the hypothesis of Poissonian input distribution, arriving to the formulation of the output distribution. (auth)

23006 ESTIMATION OF THE STANDARD ERROR OF RETENTION IN WHOLE-BODY COUNTER STUDIES AND ITS REVELANCE TO COUNTER DESIGN. Anderson, J. A. (Oxford Univ.); Warner, G. T. Phys. Med. Biol.; 15: 281-7(Apr 1970).

The function of a total body counter for many clinical uses can be specified in terms of the largest acceptable standard error of the retention estimate. A method of evaluating these standard errors is described which can also be used quite generally in radioisotope studies. The standard error of retention is used here to investigate the relative importance of the background count, the counter efficiency and the quantity of radioactive material administered to the patient. It is shown that two sodium iodide crystals 10 cm in diameter with simple shielding arrangements are quite adequate for a number of clinical absorption studies. (auth) (UK)

23007 IMPULSURILE DETECTOARELOR DE RADIATII NUCLEARE CU SEMICONDUCTOARE. (Semiconductor Radiation Detector Waveforms). Poenaru, Dorin N. Bucuresti; Editura Academiei Republicii Socialiste Romania (1968). 284p.

The principal processes of interaction of charged particles and gamma rays with matter, producing electron-hole pairs inside the solid state, are presented. The classical theory of the stopping power is supplemented with recent theories taking into account anisotropy effects due to the crystal structure of the materials (channelling). A phenomenological model for the calculation of the mean energy required for an electron-hole pair production in semiconductors is described, and their density distribution along the charged particle path, playing an important part in determining the shapes of the semiconductor detector (SD) electric pulses is calculated. The statistical fluctuations which determine a limiting resolution able to be obtained with SD are also analysed. The electrodynamics of a single electron-hole pair collection processes in principal SD types, classified according to the distribu-

tion law of the electric field, is discussed. The collection theory is presented in a unitary manner and the results are given under normalized form with a high degree of generality. The results obtained are used in the detailed analysis of all processes concurring in SD pulse formation. To the "summing" up of the elementary contributions given by pair collection, the "plasma time," influence of the device equivalent circuit elements and of the amplifier input circuit considered as a load impedance for the SD is to be added. The general results given in tables for all practically interesting cases are particularized to some simpler cases for which the waveforms are graphically plotted. The applications of the SD current pulses in nuclear spectrometry are discussed in detail, and the theoretical calculations are accompanied by experimental checkings. Unlike the work with charge pulses generally used, the SD fast response is emphasized in the current mode of operation, the only one in which at a given energy of the nuclear radiation, the pulse amplitude increases as its length decreases. These working conditions allow to do the amplitude analysis with high counting rates and provides high resolutions in the time analysis. The current pulse waveforms, their use in nuclear spectrometry, and the simultaneous extractions of a slow and fast pulse from the SD are experimentally checked with a fast transistorized, small input impedance current amplifier. Three circuit configurations frequently used in preamplifiers for SD are analysed. These circuits are: amplifier with bootstrapped plate load, cascade stage and cascade with bootstrapped load. For each of the three circuits, formulas of the gain, output impedance and transient response both in the initial (edge response) and final part (flat top response) are presented. These calculations are checked by means of a vacuum tube charge-sensitive preamplifier built at the IAP-cyclotron and used as a part of a heavy charged particle spectrometer with SD. Also, a precision mercury relay pulse generator is presented. This pulse is used for the calibration of the spectometer and for measuring the energy resolution and the SD capacity. (auth)

23008 WIRE SPARK CHAMBER FOR GAMMA RAY DETECTION. Nordberg, M. E. Jr. (Cornell Univ., Ithaca, N. Y.); Behrend, H.-J.; Harvey, J.; Lobkowicz, F.; Thorndike, E. H.; Wehmann, A. A. Rev. Sci. Instrum.; 41: 588(Apr 1970).

A unit of two 20 × 25 cm spark chambers with 20 wires per cm, preceded by a one-radiation length lead converter, for gamma ray detection is briefly discussed. The detector employs magnetostrictive wire readout. (W.H.K.)

23009 CALCULATED EFFICIENCIES OF NaI(Tl) SCINTILLATION CRYSTALS FOR MARINELLI BEAKERS WITH AQUEOUS SOURCES. Verheijke, M. L. (Philips Research Labs., Eindhoven, Netherlands). Int. J. Appl. Radiat. Isotop.; 21: 119-26(Mar 1970).

Total absolute efficiencies for 3 × 3 in. and 4 × 4 in. NaI(Tl) detectors using Marinelli beaker geometry were calculated. The accuracy for the peak efficiencies was about ±5 per cent, which was verified by means of calibration with three standardized solutions. The influence of the sample volume on the minimum detectable activity is discussed. (auth) (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 24532.

23010 (JINR-P13-4979) PULSE PILE-UP FOR A PRECISION AMPLITUDE SPECTROMETER WITH RC-FILTERS. Antyukhov, V. A.; Semenov, B. Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A device for generating a signal for blocking the triggering of the amplitude analyzer in the case of pile-up events (the pile-up inspector) is described. The performance requirements are considered, the functional and principal circuits are given, and the results of experiments are discussed. The logarithmic dependence of the blocking pulse duration upon the input signal amplitude, the absence of the self-dead time, a wide dynamic range of input signals (up to 1000), and the conservation of the performance characteristics at high counting rates provided a high efficiency for applying the inspector to the precision spectrometer channel when pulses are shaped with RC-filters. (auth)

23011 (NLCO-1053) A VERSATILE CONTROL PANEL FOR A PRODUCTION CONTROL QUANTOMETER. Kramer, J.; Bailey, M. R.; Benge, D. G. (National Lead Co. of Ohio, Cincinnati). Mar 1970. Contract AT(30-1)-1156. 13p. Dep. CFSTI.

A versatile control panel was designed and installed in a 2-meter Production Control Quantometer (PCQ). This panel permits the separate programming of the pre-integration times, the integration times, and the voltages applied to the photomultiplier tubes through the attenuators assigned to individual elements for as many as three different sample groups or matrices. Once programmed, the group selector switch on the front of the PCQ recording console automatically selects the required program conditions for any one of the three different matrix methods. (auth)

23012 (NP-18189) AN AUTOMATIC-RECORDING CONSTANT-VELOCITY MOESSBAUER SPECTROMETER. Thrane, Niels (Tekniske Hoejskole, Lyngby (Denmark). Laboratoriet for Teknisk Fysik II). Oct 1969. 61p. (In Danish). Dep. CFSTI (U. S. Sales Only).

The construction and performance of an automatic-recording constant-velocity Moessbauer spectrometer primarily for studying ^{57}Fe and ^{119}Sn is described. The spectrometer is suitable for examination of individual absorption lines in a Moessbauer spectrum. The spectrometer covers the velocity range from −10 mm/sec to +10 mm/sec with a velocity stability and resolution less than 0.01 mm/sec at low velocities. The instrument has been used for measurements on solid solutions of Sn and Sb in Fe. (Denmark)

23013 AUGER ELECTRON SPECTROMETER PREAMPLIFIER. Tracy, J. C.; Bohn, C. K. (North American Rockwell Corp., Thousand Oaks, Calif.). Rev. Sci. Instrum.; 41: 591-2 (Apr 1970).

An inexpensive tuned transimpedance preamplifier for retarding potential type Auger electron spectrometers is described. It features low input impedance allowing operation at 5 kHz where system noise is low. The high transimpedance, low noise of the FET amplifier, and good first harmonic rejection permit use of an inexpensive synchronous detector. (auth)

23014 THE FAST CHOPPER TIME-OF-FLIGHT SPECTROMETER AT THE FRG-1 AT GEESTHACHT. Biel, W.; Jung, H. H.; Richter, G. (Univ., Kiel). Atomkernenergie; 15: 91-5(1970).

A technical and physical description of the fast chopper time-of-flight spectrometer at the FRG-1 at Geesthacht is given. The spectrometer is used for transmission measurements mainly on stable and radioactive fission products. The covered energy range is from about 1 to max. 1000 eV. The highest resolution which can be used in the energy range above 50 eV is R = 31 ns/m, when the 21.5 meter station is used. Neutron intensity is —depending on energy range —from 0.6 to 0.3 neutrons/min/time-of-flight-channel, and signal to background ratio is from 5 to 15 percent, respectively. (auth)

23015 PEAK AREA DETERMINATION IN GAMMA SPECTROSCOPY BY LEAST-SQUARES LINEAR-TAYLOR DIFFERENTIAL-CORRECTION TECHNIQUE. Weber, G. Y. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 38: 537-44(1969).

The least-squares linear-Taylor differential-correction technique was used to fit a gamma-ray photopeak by the function, $K_1 + K_2x + K_3e^{-K_4(K_5-x)^2}$, and to determine the peak area. This method was mainly used to improve the reproducibility of activity measurements in activation analysis. (auth)

23016 MAGNETIC FIELD STABILIZER FOR A PAIR GAMMA SPECTROMETER. Frolov, V. F.; Zolotoi, L. F. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 55-60(1969). (In Russian).

The description of the voltage stabilization system for a magnetic field in the range 250 to 3500 oersted for a multichannel magnetic pair gamma spectrometer is given. The degree of stabilization of the magnetic field is 10^{-4}. (tr-auth)

High Energy Physics Instrumentation

23017 (CEA-CONF-1486) LAST DEVELOPMENTS ON SPARK CHAMBERS. Lansiart, A.; Morucci, J. P.; Allard, G.; Seigneur, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 11p. (In French). (CONF-700109-1). Dep. CFSTI (U. S. Sales Only).

From 9th International Symposium on Radioactive Isotopes in Clinic and Research, Bad Gastein, Austria.

Three recent developments in spark chambers are described. These are glasses having a deposit of tin oxide on each face, the use of a Be cathode and a 2 mm detection space for small-angle x-ray diffraction, and association of a collimator with spark chambers. The results obtained from each of these developments are described. (J.S.R.)

23018 (CEA-N-1258) DEVELOPMENT OF EQUIPMENT FOR THE STUDY OF HIGH-ENERGY-PARTICLE ELASTIC SCATTERING OVER A WIDE ANGULAR RANGE. Berger, Jacques (Commissariat a l'Energie Atomique, Saclay (France).

Centre d'Etudes Nucleaires). Feb 1970. 109p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

The equipment for a series of experiments performed in the CERN proton synchrotron in Geneva, in order to study πp, Kp and $\bar{p}p$ elastic scatterings for lab. angles between 5 and 175° and for incident momenta of about 3.5 GeV/c, is presented. The apparatus includes detectors (thin plate optical spark chambers and associated counters) as well as the electronic logics to select the scattering events. A gas Cherenkov counter with a large cross-sectional area (≈1 m^2) and diffusing walls is studied in detail. The differential elastic scattering cross sections obtained are given. (France)

23019 (LAL-1227) TEST OF ORIGINAL GEOMETRY FOR SOLVING THE LARGE BUBBLE CHAMBER PROBLEMS. Pascaud, C.; Morellet, D. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jan 1970. 115p. (In French). Dep. CFSTI (U. S. Sales Only).

The uncertainties due to the physical effects are included a priori in the matrix of covariances directing the particle trajectory fits. Because of economy the problem of geometry is separated into two distinct operations. The two operations are very similar and differ only by the degrees of approximations used. The reconstruction of the QCP points is given, and the method of β transfer matrices is described in detail. A simplified schematic is given for the calculation of G^{-1} and of the matrix of the weights accumulated on the QCP points. Problems connected with particles at rest are considered. The approximations necessary for the final fit are evaluated. (J.S.R.)

23020 (RHEL/R-189) THE ROUGH DIGITISINGS "MERGE" PROGRAM. Girard, P. M. (Rutherford High Energy Lab., Chilton (England)). Jan 1970. 23p. Dep. CFSTI (U. S. Sales Only). UK 3s. 6d.

Before a bubble-chamber event can be measured accurately using the HPD, it is necessary to examine the film by eye and record the approximate position of each track by digitizing three points along its length. This is done with the assistance of Rough Digitizing machines, which project an enlarged image of the film onto a white table and allow the operator to record measurements automatically by means of a "puck" placed in turn at the points to be digitized. The machines are operated on-line to an IBM 1130 computer and the measurements are stored initially on a disk on the 1130. When the 1130 disk is sufficiently full, its contents are added to the end of existing data, if any, on a large disk attached to the 360/75 computer. There they are examined by a program called "Elephant" running in the 360, which subjects the digitizings for each event to various checks for validity and outputs its conclusions on the line-printer. The function of the MERGE program, which is run next, is to prepare batches of rough-digitized events for feeding into the HPD control program. It collects together from 360 disk the various fragments of data belonging to particular rolls of film, arranges everything in the correct order, and writes a stream of rough digitizings away to magnetic tape in a form suitable for subsequent processing. Finally it frees the disk space formerly occupied by these events so that it can be used again. (auth)

23021 MNOGOKRATNOE RASSEYANIE CHASTITS V YADERNYKH FOTOEMUL'SIYAKH. (Multiple Particle Scattering in Nuclear Photoemulsions). Voinov, V. G.; Chasnikov, I. Ya. Alma-Ata, USSR; Izdatel'stvo Nauka Kazakhskoi SSR (1969). 132p.

A brief review is given of theoretical and experimental data on multiple Coulomb scattering of charged particles in nuclear emulsions. Comparisons were made of various methods for determining particle energies by their scattering. The noise distortions, and spurious scattering and methods used for excluding the spurious scattering are also discussed. (148 references.) (R.V.J.)

23022 ANALYSIS OF AN IONOGRAPHIC SIGNAL. Dellagi, Mohamed (Univ., Tunis). Compt. Rend., Ser. B; 269: 1324-7(22 Dec 1969). (In French).

High-energy particle tracks in a nuclear emulsion are considered. The fluctuations of the various differences of the sagitta are due to grain effects of which the causes are calculated. This result is applied to the resolution of several multiple scattering problems. (tr-auth)

Radiation Dosimeters

Refer also to abstracts 22995, 23197, 23211, 23212, 23217, 23361, and 23362.

23023 (NP-18058) REPORT OF THE RADIATION MEASURING SERVICE ASD/M FOR THE YEAR 1968. Piesch, E. (ed.) (Kernforschungszentrum, Karlsruhe (West Germany)). Jun 1969. 131p. (In German). Dep. CFSTI (U. S. Sales Only).

Covering the year 1968, a routine health physics report on the monitoring of personnel at the Karlsruhe Nuclear Center was compiled. Special emphasis was placed on the development and testing of solid state dosimeters for depth dose determinations independent of incidents angle of radiation. These dosimeters, consisting of phosphate glass, were developed for personnel monitoring, for telemetric transmission of radioactivity data to specific locations, and for measuring radioactivity of waste disposal systems. In addition, equipment and safety measures were developed and described for recognizing unusual radioactivity emitted from the stack of the center and leading to possible contamination of the environment. (tr-auth)

23024 (NP-18105) VARIATION WITH TEMPERATURE OF THE ELECTRIC CONDUCTIVITY (NATURAL AND UNDER RADIATION) OF DIELECTRIC LIQUIDS. APPLICATION TO THE MEASUREMENT OF THE ACTIVATION ENERGY BOUND TO THIS CONDUCTION. Delard, Rene (Toulouse Univ. (France). Faculte des Sciences). [1968]. 85p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

It was found that each liquid dielectric possesses an activation energy suitable for its intrinsic current as well as for its ionization current. The effects of temperature, important to the intrinsic current or on the background noise of the dosimeters, is clearly weaker on the ionization current (at a factor of about 10). The role of impurities and of some traces of moisture in the natural and induced conduction of liquid dielectrics was also found. It is necessary to purify them and to dry them thoroughly in order to determine the activation energy of the intrinsic current. In contrast, the activation energy of the induced current is constant when the conductivity of the liquid is above 10^{17} ohms cm for 25 kV cm^{-1}. If the activation energy varies with the electric field, it also varies with the length of the carbon chain (normal alkanes); also, the substitution of certain hydrogen atoms by radicals (ethyl or methyl) modifies this value. CCl_4 has an exceptionally low activation energy. It it is mixed with other liquid dielectrics, it behaves as an ionization inhibitor. The determination of the values for activation energy permits the preparation of some detectors possessing a weak coefficient of temperature (0.2 to 0.4% by Celsium temperature scale). (tr-auth)

23025 (NP-18179) NATURAL CALCIUM FLUORIDE AS RADIATION THERMOLUMINESCENT DOSIMETER. Maza del Torno, Victor Manuel (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ingenieria). 1969. 61p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The properties of natural calcium fluoride as a thermoluminescent dosimeter are studied. The phenomenon of thermoluminescence is described and a mathematical model is given. Possible applications of thermoluminescent dosimetry are considered. The experiments carried out are described and the results obtained are shown graphically. (J.S.R.)

23026 (ORNL-tr-2286) TISSUE DOSIMETRY OF RADIATION GENERATED BY HIGH ENERGY ACCELERATORS. Golovachik, V. T.; Dmitrievskii, I. M.; Komochkov, M. M.; Lebedev, V. N.; Lysak, Yu. D.; Semonov, Yu. V.; Frolov, V. V.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translation of report JINR-P16-4765. 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 9695.

23027 THERMOLUMINESCENT PELLETS. (to Kewanee Oil Co.). British Patent 1,186,899. 8 Apr 1970. Priority date 22 Aug 1966, United States.

An extrusion process for fabricating activated lithium fluoride pellets for dosimetry is described. Temperature and pressure requirements for the extrusion process are presented. After extrusion, the pressed powder is cut or sliced to the desired size. (W.H.K.)

23028 A LIQUID ACTIVATION DOSIMETRY SYSTEM FOR 14.7 MeV NEUTRONS. Nicholson, P. W. (Middlesex Hospital Medical School, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 105-7 (Feb 1970).

An activation method to measure the mean neutron flux of a small D-T 14.7 MeV neutron generator was required in connection with an investigation of chromosome aberrations following irradiation of a suspension of human lymphocytes. The factors governing the choice of a suitable substance for activation are discussed and the reasons for using magnesium acetate given.

The mechanism of neutron interaction in both the sample and magnesium acetate solution is examined and the method of calculation of the dose delivered to the biological sample considered. The sources of possible error are discussed. (UK)

23029 THE CONSISTENCY OF $FeSO_4$ DOSIMETRY. Law, J. (Royal Infirmary, Edinburgh). Phys. Med. Biol.; 15: 301-9 (Apr 1970).

Ferrous sulphate (Fricke) dosemeter solutions from five laboratories have been intercompared. Differences in their ferric ion yields do not exceed 0.5% and are not statistically significant. For all the solutions, precautions were taken to remove impurity effects arising from the sulphuric acid. Spectrophotometers used in these five laboratories for measurement of ferric ion concentrations were also intercompared. Significant differences of over 1% were found between independent determinations of the ferric ion extinction coefficient, and errors in this measurement are now one of the major contributions to the overall uncertainty in ferrous sulphate dosimetry. (auth) (UK)

23030 THE ENERGY RESPONSE OF LiF, CaF_2, AND $Li_2B_4O_7$:Mn TO HIGH ENERGY RADIATIONS. Almond, Peter R.; McCray, Kenneth (Univ. of Texas, Houston). Phys. Med. Biol.; 15: 335-42(Apr 1970).

The decrease in sensitivity of ^{7}LiF to high energy electrons and x-rays when compared with ^{7}LiF exposed to ^{60}Co γ-rays was further investigated and the energy dependence measurements were also done for CaF_2 and $Li_2B_4O_7$. Measurements were made at electron energies of 6 to 18 MeV, x-ray energies of 18.5 and 22 MeV, and for γ-rays from ^{137}Cs and ^{60}Co. The 6–10% decrease in response for LiF was confirmed, and a 3% decrease was found for both CaF_2 and $Li_2B_4O_7$. The difference in response between ^{7}LiF and the other phosphors can be considered as real, since the exposures at each energy were made using the same calibrations. To explain the results, the general cavity theory derived by Burlin has been used; good agreement with the experimental data is obtained over the entire range investigated. (auth) (UK)

23031 USE OF GLUCOSE SOLUTIONS IN ^{60}Co GAMMA RAY DOSIMETRY. Russell, R. D. (Central Electricity Generating Board, Berkeley, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 143-6(Mar 1970).

The change in the optical rotation of aqueous solutions of glucose on irradiation with γ-rays was calibrated for use as a chemical dosimeter. The method was shown to be suitable for use in glass or metal systems and is not sensitive to contamination by many common laboratory materials. Comparison with the results of other workers shows that the method is reproducible to within ±2 per cent, linear up to a total absorbed dose of at least 250 Mrad, and independent of dose rate between 0.065 and 16 Mrad hr^{-1}. (auth) (UK)

23032 A SIMPLE AND INEXPENSIVE CHEMICAL RADIATION DOSE INDICATOR. Moos, W. S.; Nagl, J.; Haider, J. (IAEA, Vienna). Int. J. Appl. Radiat. Isotop.; 21: 177-8(Mar 1970).

The system makes use of the radiation induced changes in chloral hydrate solutions. The chloral hydrate solution used was of concentration 0.83g/ml distilled water and pH 5.0 to 5.5, and Merck Universal Indicator color changes were employed to index the dose. The response to γ radiation was a gradually decreasing intensity of the red color with increasing dose, leaving the solution colorless at the maximum of the dose range; color changes are tabulated. During a period of 4 to 8 weeks no observable color changes were noticed in ampules stored at 18° to 24°C in the dark. The solutions also do not appear oversensitive to light. Tests with fast neutrons indicated that the system might also be applicable in neutron fields. It is considered that the chemical mechanisms are somewhat more complex than the simple chloral hydrate to HCl conversion. (UK)

23033 THE EMISSION SPECTRUM OF THERMOLUMINESCENT-DOSIMETRY-GRADE LITHIUM FLUORIDE. Harris, A. M.; Jackson, J. H. (Berkeley Nuclear Labs., Eng.). J. Phys., D (London); 3: 624-7(Apr 1970).

The change in the emission spectrum of irradiated thermoluminescent lithium fluoride is investigated as a function of specimen temperature. The emission peak energy rises with temperature and it is suggested that a temperature dependence upon the luminescent efficiency of the recombination process is responsible rather than an association of specific emission peaks with individual glow peaks. (auth) (UK)

Radiometric Instruments

Refer also to abstract 23248.

23034 INDUSTRIAL ISOTOPIC METERS AND REGULATORS. Scharf, W. (Office of Nuclear Apparatus, Warsaw). Pomiary, Automat., Kontr.; 15: 241-7(1969). (In Polish).

Isotopic meters and regulators for industrial applications, designed by the Biuro Konstrukcyjne Zakladu Doświadczalnego Żerań BUTJ, and produced by home factories are discussed. Description is given of the universal measuring set, type ZPU, and also of isotopic thickness gages and gammas-per-square-meter gages based upon this set. Also discussed are their usefulness and range of application. (auth) (NSA of Poland)

Miscellaneous Instruments and Components

Refer also to abstracts 23423, 23674, 23680, 23771, 24784, and 24825.

23035 (CEA-N-1257) TECHNIQUE FOR GENERATING LIQUID AEROSOLS IN DISCONTINUOUS REGIME USING A HIGH-YIELD, LINEAR PRODUCTION GENERATOR. Ducousso, Roger; Carca, Pierre; Pasquier, Christian; Perrault, Gerard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 9p. (In French). Dep. CFSTI (U. S. Sales Only).

A technique for administering liquid aerosols to monkeys is described: the pulmonary contamination yield reached 6 to 8 percent whereas it has never exceeded a few per thousand with the techniques commonly used. Aerosols were produced at a pulsating rhythm by means of a Bird pulverization generator fitted to a vibrator. Both a linear production and a best yield are obtained. (France)

23036 (INR-1154) SLIDING PULSE GENERATOR FOR DIFFERENTIAL LINEARITY MEASUREMENTS. Kulka, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 19p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The increasing resolution of pulse height analyzers requires a better knowledge of their differential linearity. Automatic testing of differential linearity is done by feeding a train of steadily higher pulses into the pulse height analyzer at a constant rate. A sliding pulse generator for differential linearity measurements has been built. Its operation principle and performances are described. The results of the measurements are given. (auth)

23037 (NP-18156) GREEK ATOMIC ENERGY COMMISSION. Progress Report up to the end of 1966. Rakintzis, N. Th.; Katsanos, N. A. (Atomic Energy Commission, Athens (Greece)). 1968. 168p. Dep. CFSTI (U. S. Sales Only).

A brief review is given of the activities of the Greek AEC from its foundation to the end of 1966. The experimental facilities are also briefly described. Research programs in high energy physics, nuclear physics, atomic physics, solid state physics, reactor physics, chemistry, biochemistry, biology, medicine, geology, soil science, electronics, and health physics are outlined. Abstracts of original publications, theses, review articles, and other reports are included. Finances are briefly discussed. (C.E.S.)

23038 (NP-18159) GREEK ATOMIC ENERGY COMMISSION. Annual Report, 1967. (Atomic Energy Commission, Athens (Greece)). Apr 1969. 139p. Dep. CFSTI (U. S. Sales Only).

Research programs in high energy physics, nuclear physics, solid state physics, reactor physics, chemistry, biology, health physics, geology, electronics, and agriculture are briefly outlined. Publications issued during the year are listed. International and public relations, finance, and administrative organization are also briefly discussed. (C.E.S.)

23039 (NYO-3124-3) FABRICATION OF SILICON MICROCIRCUITS BY NEUTRON TRANSMUTATION DOPING. Final Report. Klahr, Carl N.; Cohen, Melvin S. (Fundamental Methods Associates, New York). 31 Dec 1968. Contract AT(30-1)-3124. 147p. Dep. CFSTI.

The objective was to develop practical and reproducible techniques for fabrication of complex microcircuits in silicon by neutron transmutation. This required the development of a number of new methods for (a) prediction of the spatial pattern of the neutron flux when radiation dies are used; (b) application of silicon dioxide technology to transmutation-doped configurations; (c) fabrication of radiation dies using cadmium-113 integrally plated onto silicon wafers and of radiation capsules for silicon wafers; (d) design of microcircuits compatible with transmutation-doped configurations; (e) development of techniques for etching radiation dies, oxides and metallization layers to high resolution; and (f) development of methods for making good electrical contacts to transmutation-doped silicon. These methods and the radiation experiments for which they were used are described.

The irradiation experiments performed were directed toward two microcircuit applications for which transmutation appears to have unique capabilities: (1) fabrication of failure-free microcircuit doping over large areas (an entire wafer) taking advantage of the uniformity of the neutron flux; and (2) fabrication of bi-type high resistivity silicon substrates which can subsequently be processed by diffusion into complementary MOS circuits. These two application areas are described in detail. Fabrication of bi-type high resistivity silicon substrate material has been demonstrated. Furthermore, although large-area microcircuits have not yet been produced in this work, the principal difficulties seem well understood. The primary obstacle has been the fact that no single, specific irradiation location has been available in the one reactor (ORR) where known and reliable neutron flux parameters could be applied in the capsule designs. A successful irradiation requires an nvt which is controlled within a precision of 10% to 20%. Thus, lacking the necessary information for their various irradiation locations, one capsule was over-irradiated and two were under-irradiated. Nevertheless, the entire processing method and procedures for microcircuit production have been developed and it has been shown that all of the required procedures can be performed. These are described in detail. (auth)

23040 (TID-25381) CONSTRUCTION AND USE OF A HIGH RESOLUTION PHOTOELECTRON SPECTROMETER. Pullen, Bailey Price (Tennessee Univ. [Knoxville]). Mar 1970. 117p. Dep. CFSTI.

Thesis.

A He discharge lamp which emits primarily 21.22 eV photons in conjunction with an electrostatic deflection type electron spectrometer has been constructed for irradiating compounds and then submitting the ejected photoelectrons to energy analysis. For this energy analysis, the photoelectrons are allowed to pass through two small slits into the region between two spherical sector plates held at a predetermined voltage difference. Photoelectrons of a given energy then emerge through two exit slits, the outer one positioned 180° from the first entrance slit, where they are detected by an electron multiplier. The photoelectron spectra of CO, CH_4, SiH_4, GeH_4, CH_3F, CH_2F_2, CHF_3, BF_3, BCl_3, SF_6, NF_3, CF_4, SiF_4, CH_3Cl, and CF_3Cl were measured and are presented. (W.H.K.)

23041 (UUIP-663) ON THE EVALUATION OF RELIABLE PARAMETERS FOR THE DESCRIPTION AND DESIGN OF FLAT SPECTROMETERS. Groth, T. (Uppsala Univ. (Sweden). Inst. of Physics). Nov 1969. 43p. Dep. CFSTI (U. S. Sales Only).

Flat spectrometers are customarily described by the radial variation of the field intensity in the plane of symmetry: $B_Z(r,0) = B_0\Sigma_{n=1}^{\infty} a_n(r-r_0/r_0)^n$. The usefulness of the expansion coefficients a_n in the design of a spectrometer is highly dependent on the reliability of these coefficients as descriptive parameters. The successful application of Chebyshev approximation methods to the problem of evaluating reliable coefficients is reported and the shortcomings of commonly used standard procedures are also pointed out. The methods are applied to the optimum field giving 12 expansion coefficients, the first seven of which coincide with those theoretically derived by Lee-Whiting and Taylor. (auth) (Sweden)

23042 SPIN ANALYZER FOR LOW-ENERGY ELECTRONS. Gehenn, W.; Haug, R.; Wilmers, M.; Deichsel, H. (Univ., Mainz). Z. Angew. Phys.; 28: 142-3(1 Dec 1969). (In German).

The construction of a small analyzer for detecting the spin polarization of slow electrons is described. The scattering target is an Hg atmosphere. The parameters of the analyzer are: Electron energy = 6.75 eV, scattering angle = 95°, Sherman factor = + 0.21 ± 0.01, sensitivity = 2×10^{-4}, noise = 1 pulse/10 min. (auth)

23043 THERMAL STABILITY OF THE GAIN OF AN AMPLIFIER FOR NUCLEAR SPECTROMETRY. de Rosny, G. (Commissariat a l'Energie Atomique, Cadarache, France). Onde Elec.; 50: 123-31(Feb 1970). (In French).

The contribution of the components which are principally at the origin of the thermal deviation of the gain of an amplifier for nuclear spectrometry is studied. It is shown, in particular, that it is profitable to know the dispersion of the thermal coefficients of these components. The calculations are applied to two types of amplifiers whose completion network comprises resistances, capacitors and delay lines. (France)

23044 TRAPPED ION ANALYZER CELL FOR ION CYCLOTRON RESONANCE SPECTROSCOPY. McIver, Robert T. Jr. (Stanford Univ., Calif.). Rev. Sci. Instrum.; 41: 555-8(Apr 1970).

Ion cyclotron resonance spectroscopy has been adopted for the detection of gaseous ions formed within an analyzer cell of new design. Ions formed by electron impact have been trapped within the analyzer cell for as long as 0.10 sec and detected with a half-height mass resolution of 5000. Even at pressures of 10^{-5} Torr ion–molecule reactions of high kinetic order may be observed. An important feature of the trapped ion analyzer cell is that it retains the capability of the ICR double resonance experiment for elucidating the reaction sequence occurring in a complex mixture of primary ions and high order product ions. A pulsed magnetic field detection scheme accurately limits the residence time of the ions within the trapped ion analyzer cell. (auth)

23045 A SIMPLE AND INEXPENSIVE LOW DENSITY MICROWAVE INTERFEROMETER SYSTEM. Brown, Ian G.; Compher, Alan B.; Hopkins, Donald B. (Univ. of California, Berkeley). Rev. Sci. Instrum.; 41: 600-1(Apr 1970).

A microwave interferometer for measuring laboratory plasma densities as low as $10^9/cm^3$ is described. (W.H.K.)

23046 X-RAY SPECTROMETRY OFFERS BETTER PROCESS CONTROL. Page, J. S. R. Australas. Eng.; 61: 13-15 (Sep 1969).

Specifications and applications of the PW1270 X-ray spectrometer are given. (Australia)

Radiation Effects on Instruments and Instrument Components

23047 (ANL-Trans-812) OPTICAL PROPERTIES OF DOSIMETRIC CRYSTALS OF LITHIUM FLUORIDE. Grube, M. M.; Shvarts, K. K.; Grant, Z. A. Translated for Argonne National Lab., Ill., from Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 4, 7-12(1968). 11p. Dep. CFSTI.

Color centers and luminescence of LiF : Mg, Ca crystals applied to thermoluminescence dosimetry were studied. The thermoluminescence curve contains eight peaks: 140°C, 175°C, 200°C, 240°C, 290°C, 330°C, 400°C and 480°C. The peaks at 140°C, 175°C and 200°C are connected with supplementary absorption bands in the region 240 to 400 nm. The maximum intensity peak at 240°C and the high-temperature peaks are connected with the F-band and neighboring short-wave bands. Four bands (120 nm, 138 to 144 nm, 170 to 190 nm, and 190 to 200 nm) are detected in the excitation spectrum. The maximum of the emission spectrum is located in the 410 nm region. (auth)

23048 EFFECTS OF DISLOCATIONS ON RADIATION DAMAGE OF SILICON SOLAR CELLS. Usami, Akira (Nagoya Inst. of Tech., Japan). Oyo Butsuri; 39: 49-53(Jan 1970). (In Japanese).

Dislocations were introduced on the surface of a P/N-type Si solar cell by indenting it with a loaded diamond point and simultaneously annealing it. Increases of nonsaturable reverse current and of n value in forward characteristic, $I_0(e(qV/nk\,T) - 1)$, were observed on the indented cells. In another type of cell, dislocations were introduced from the back surface by thermal annealing after the mechanically damaged layer was formed by the air blasting method. On this cell, a small increase of n values and of reverse current was observed. The degradation of minority carrier lifetime and the proportional factors of defect introduction rate, $\Delta(1/\tau) = 1/\tau_\gamma - 1/\tau_0$, of these dislocation-introduced cells were smaller than those of the normal cells under γ-irradiation. The interaction between defects and dislocations is considered from the isochronal annealing characteristics. (auth) (NSA of Japan)

23049 EFFECTS OF γ RADIATION ON PROPERTIES OF LASERS. Arifov, U. A.; Bedilov, M. R.; Khaidarov, K. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 8, 14-16(1969). (In Russian).

Gamma radiation effects on the generation properties of a tetralevel laser activated by tri-valent neodymium were studied. Data obtained showed that at a radiation dose of 10^{14} rad the efficiency of the OQG was reduced four fold, the excitation threshold increased 1.6 fold, and the ratio of angular pitch tangence reduced as much in comparison with the corresponding characteristics of the OQG before irradiation. Thus, it was found that γ-radiation considerably affects the energy levels and the probability of the Nd^{3+} ion transitions. Thus, theoretical calculations should take into account the effects of color centers in the tetra-level laser system. (R.V.J.)

23050 STABILITY OF PREVIOUSLY IRRADIATED M.O.S. TRANSISTORS AT HIGH TEMPERATURES. Buxo, Jean; Martinez, Augustin; Esteve, Daniel (CNRS, Toulouse). Compt. Rend., Ser. B; 269: 1146-9(3 Dec 1969). (In French).

The importance of the conditions of electric polarization on the thermal annealing of previouly irradiated M.O.S. transistors is shown. The analysis of experimental results shows the existence of physico–chemical modification of the irradiated silica and suggests attributing it to an electron emission by the Schottky effect, the origin of the neutralization of positively charged traps created in the silica by the irradiation. (tr-auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstracts 22592, 22605, 22993, 23003, 23035, and 23271.

23051 (BNWL-1183-2) THE MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. DETERMINATION OF THE RADIONUCLIDE CONTENT OF FECES AND URINE FROM ASTRONAUTS ENGAGED IN SPACE FLIGHT. Quarterly Research Report to the NASA Manned Spacecraft Center, July 1-October 5, 1969. Brodzinski, R. L.; Rancitelli, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Oct 1969. Contract AT(45-1)-1830. 30p. Dep. CFSTI.

In an attempt to foresee any possible metabolic changes caused by conditions of weightlessness and prolonged physical inactivity in astronauts, that are manifested by an uptake or loss of an element or elements by their bodies, in-flight fecal samples were collected from the astronauts on the Apollo 7 and 9 missions and analyzed by neutron activation and γ-ray spectrometry for the concentrations of 17 elements. Calcium determinations by the same methods were made on samples from the Apollo 7, 8, 9, and 10 missions. Data are presented in tabular form for the following elements: Apollo 7 and 9-Na, K, Rb, Cs, Fe, Co, Zn, Cr, Sc, Br, Se, Hg, Ag, Sb, Au, and Sn; Apollo 7, 8, 9, and 10-Calcium. Six of the elements (Ca, Co, Fe, K, Na, and Sn) demonstrated variance with the expected fecal excretion rates based on normal dietary intake. Examination of 20 3-in squares from the outermost filter of the air purification cannister on board the Apollo 10 spacecraft for ^{147}Pm contamination revealed that no substantial quantity of promethium was present in the space capsule environment. The ^{210}Po content of the outer skin of the Apollo 8 spacecraft was measured in an attempt to determine the uranium content of the moon. A significant difference was found between the calculated value and the determined value following autoplating of the ^{210}Po on a polished silver disk and counting in an alpha diode spectrometer for 8000 min. The possible reasons for this discrepancy are discussed. (E.R.B.)

23052 (CONF-690501-, pp 63-71) DEVELOPMENT OF A THYROTOXIC FETUS IN THE UTERUS OF A EUTHYROID MOTHER. Czerniak, P.; Soferman, N.; Chajchik, S. (Tel Aviv Univ., Israel).

It is possible to investigate the fetal physiopathology in humans by administering tracer doses of radionuclides to pregnant women when their pregnancy must be interrupted for medical reasons. This fetal radiocontamination may be valid by choosing adequate radiomarkers that freely cross the placental barrier, are taken up by fetal target organs, undergo metabolic changes in the fetal body, and can be finally studied after artificial delivery with conservation of fetal anatomy. Radioiodine was used for such a study performed in 6- and 4.5-month-old fetuses for the investigation of the fetal thyroidology. The following was found: After an early histogenesis, thyroid physiogenesis starts. The fetal thyroid tissue first becomes iodophil and then starts with organification and coupling. Iodotyrosines and iodothyronines are synthesized. The thyroid activity is small at the fetal age of 4.5 months, but it grows and becomes hyperactive (even in the body of a euthyroid mother) at the age of 6 months. A part of the iodine and of the protein-bound-iodine (PBI) compounds are found in the amniotic fluid (excreted by the fetal kidneys). The amounts are correlated to the fetal thyroid uptake. The following radioiodine methods were used: uptake, excretion, conversion ratio, butanol extractable iodine, radiochromatography, RBC uptake test of ^{125}I-labeled T_3, and scintillography. (auth)

23053 (NYO-3924-6) AN EVALUATION OF RADIOIODINE-LABELED 5-IODO-2'-DEOXYURYDINE AS A TRACER FOR MEASURING CELL LOSS FROM SOLID TUMORS. Dethlefsen, Lyle A. (Pennsylvania Univ., Philadelphia. Dept. of Radiology). 8 Feb 1970. Contract AT(30-1)-3924. 8p. Dep. CFSTI.

5-Iodo-2'-deoxyuridine (IUdR) labeled with ^{125}I is the current tracer of choice for measuring cell loss in vivo from undisturbed solid tumors. The following limiting conditions hold: the tumor DNA must be extracted in order to reliably measure the radioactivity; the chemical and radiation dose must be kept low and should be evaluated in each new situation to be studied; and one must realize the potential for low levels of IUdR reutilization even in undisturbed tumors. In perturbed situations (i.e., chemical or radiation induced killing) this problem may become severe. (auth)

23054 (UCLA-12-765) THE BIOSYNTHESIS OF UNSATURATED FATTY ACIDS BY BACILLI. II. TEMPERATURE DEPENDENT BIOSYNTHESIS OF POLYUNSATURATED FATTY ACIDS. Fulco, Armand J. (California Univ., Los Angeles). [1 Apr 1970]. 28p. Dep. CFSTI.

Bacillus licheniformis 9259 has been shown to synthesize two ^{14}C polyunsaturated fatty acids from endogenous or added palmitate at 20° but not a 35°. Ready conversion of added palmitic acid labeled with ^{14}C or ^{3}H to these fatty acids by cultures of B. licheniformis incubated at 20° permitted the isolation of sufficient amounts of material for the determination of structure and label distribution by physical and chemical methods. The major polyunsaturated component was shown to be 5,10-hexadecadienoic acid while a minor component had the 7,10-double bond configuration. It was further shown that the biosynthesis of the major dienoic acid resulted from the cooperative action of two distinct desaturation systems. One system, which was present at both 35° and 20° desaturated palmitic acid to 10-hexadecenoic acid. A second system active only at the lower temperature, resulted in the conversion of palmitic acid to 5-hexadecenoic acid. This system, which had previously been studied in B. megaterium, is apparently not present at 35° but is rapidly induced at 20°. Utilizing ^{3}H-labeled 10-hexadecenoic and 5-hexadecenoic acids which were prepared biosynthetically, it was possible to show that, at 20°, either substrate could serve as a precursor for the biosynthesis of 5,10-hexadecadienoic acid by B. licheniformis. Indeed, they were both more effective in this regard than palmitic acid added in similar concentrations. Although added palmitic acid is also converted to 7,10-hexadecadienoic acid at 20°, there was no evidence for the formation of the monoene, 7-hexadecenoic acid at either 35° or 20°. Presumably, the substrate for Δ^7-desaturation is 10-hexadecenoic acid. The finding that B. licheniformis can carry out the conversion of palmitate to 5,10- and 7,10-hexadecadienoic acids apparently represents the first unequivocal demonstration of de novo polyunsaturated fatty acid biosynthesis in bacteria. (auth)

23055 IRON KINETICS AND WHOLE-BODY SCANNING OF IRON USING LESS THAN 5 μCi OF ^{59}Fe. Winchell, H. S.; Landaw, S. A. (Univ. of California, Berkeley). J. Nucl. Med.; 11: 181-2(Apr 1970).

A simplified method of measurement of iron kinetics in patients is described. A four to five μCi dose of ^{59}Fe is incubated with autologous or homologous plasma having a sufficiently high latent iron-binding capacity to ensure complete binding of iron to transferrin. The plasma containing the transferrin-bound iron is administered intravenously and plasma samples are obtained at 10 to 90 min intervals for the determination of plasma-iron turnover rates. Whole-body scans are made on the 1st, 7th, and 14th day and a blood sample is obtained for estimation of ^{59}Fe incorporation into circulating erythrocytes. The data are used to estimate hemoglobin synthesis rate and mean circulating erythrocyte turnover time. The interpretation of scan data in patients with hematopoietic dyscrasias is discussed. (C.H.)

23056 ENERGY ASSIMILATION BY THE HOUSE CRICKET, ACHETA DOMESTICUS, MEASURED WITH RADIOACTIVE ^{51}Cr. Crossley, D. A. Jr.; Van Hook, Robert I. Jr. (Oak Ridge National Lab., Tenn.). Ann. Entomol. Soc. Amer.; 63: 512-15(Mar 1970).

A radioisotope method for determining energy assimilation for energy flow studies is discussed. Concentrations of ^{51}Cr in food and feces, along with caloric measurements on these materials, were used to estimate energy assimilation independent of intake-defecation budgets. Adult house crickets, Acheta domesticus (L.) (Orthoptera: Gryllidae), were allowed to feed on ^{51}Cr tagged food for 24 hours and then were transferred to nonradioactive food. Their feces were collected at hourly intervals for the next 24 hours. Regression analysis was used to estimate ^{51}Cr content in the gut at the time of their transfer to a nonradioactive food. The data on the crickets yielded an estimate of 65% for energy assimilation efficiency. Gravimetric determination of energy assimilation efficiency was 63%, based on intake-defecation budgets. (auth)

23057 PVP: A PRACTICAL STABILIZER FOR ^{99m}Tc-SULFUR COLLOID. Ege, Guenes; Richards, Lorna (Princess Margaret Hospital, Toronto). J. Nucl. Med.; 11: 175-6 (Apr 1970).

A method is described for the preparation of ^{99m}Tc-sulfur colloid stabilized with polyvinylpyrrolidone. The advantages

of using this compound, rather than dextran-stabilized ^{99m}Tc–sulfur colloid, for liver or spleen scanning are discussed. (C.H.)

23058 SOLID-PHASE RADIOIMMUNOASSAY FOR SHEEP GROWTH HORMONE. Trenkle, Allen (Iowa State Univ., Ames). Proc. Soc. Exp. Biol. Med.; 133: 1018-22(Mar 1970).

A procedure for solid-phase radioimmunoassay of ovine and bovine growth hormone (GH) is described. Fasting sheep with functional rumens did not result in increased plasma GH levels. Young calves had somewhat higher levels of plasma GH than did mature cows. (auth)

23059 RADIOACTIVE GIBBERELLIN A_5 AND ITS METABOLISM IN DWARF PEAS. Musgrave, Alan; Kende, Hans (Michigan State Univ., East Lansing). Contract AT(11-1)-1338. Plant Physiol.; 45: 56-61(Jan 1970).

Radioactive gibberellin A_5 ($^3H-GA_5$) was synthesized from gibberellic acid. When it was applied to dwarf peas grown in the dark, an average of 3% was converted to another acid gibberellin within 48 hours. The biological activity of the metabolite did not account for the response to applied GA_5. GA_5 is therefore assumed to be biologically active per se. Tritium-labeled gibberellin did not appear to form a stable complex with a macromolecule in pea shoots. When injected into dwarf pea pods, $^3H-GA_5$ was readily metabolized by maturing seed to more water-soluble substances and to two other acidic compounds. This metabolism continued even throughout germination of the seed without reconversion of the metabolites to GA_5. It is concluded that bound GA_5 plays no part in the germination of dwarf pea seeds. (auth)

23060 EFFECT OF HEPARIN ADMINISTRATION ON PLASMA GROWTH-HORMONE CONCENTRATIONS. Tsushima, Toshio; Matsuzaki, Fukashi; Irie, Minoru (Tokyo Univ. Toranomon Hospital, Tokyo). Proc. Soc. Exp. Biol. Med.; 133: 1084-7(Mar 1970).

Plasma growth hormone (GH), fatty acids (FFA), glucose, and a-amino nitrogen levels were determined in seven young men after heparin administration. Plasma FFA increased rapidly, followed by a gradual fall. Corresponding to the fall of plasma FFA, a marked rise of plasma GH was demonstrated by radioimmunoassay methods. This GH rise was diminished when plasma FFA was kept elevated, or when glucose was given. From these results it was concluded that the fall of plasma FFA could stimulate GH secretion as in the case of falling blood glucose values and that the fluctuation of plasma FFA could be one of the factors regulating the secretion of GH. (C.H.)

23061 INSULIN RADIOIMMUNOASSAY BY MODIFIED HALES AND RANDLE PROCEDURE: RESULTS AND ITS PHYSIOPATHOLOGICAL SIGNIFICANCE. Scandellari, C.; Federspil, G.; Tristotto, A.; Frezzato, S.; Tiengo, A.; Muggeo, M.; Crepaldi, G. (Univ., Padua). Acta Isotop.; 9: 145-60(31 Dec 1968). (In Italian).

Modifications to the insulin radioimmunoassay technique of Hales and Randle which simplify the method for clinical purposes are described. (auth)

23062 LEVELS OF LUTEINIZING HORMONE IN SERA AND PITUITARIES OF EWES DURING THE ESTROUS CYCLE AND ANESTRUS. Roche, J. F.; Foster, D. L.; Karsch, F. J.; Cook, B.; Dziuk, P. J. (Univ. of Illinois, Urbana). Endocrinology; 86: 568-72(Mar 1970).

The levels of LH, as determined by radioimmunoassay, in pituitaries and sera of ewes during the estrous cycle and anestrus are described. The mean concentration of LH ($\mu g/g \pm SE$) in pituitaries was 112 ± 15 on the first day of the estrous cycle and increased steadily to 374 ± 47 on day nine. Concentrations in the pituitary fluctuated from 613 ± 67 to 537 ± 32 on days 11 to 15 and increased to 998 ± 91 during the proestrus. The concentration of LH in serum between the ovulatory peaks was <2 ng/ml during the estrous cycle. The mean concentration of LH in pituitaries in anestrus from May to August varied from 431 ± 27 to 300 ± 42. The differences among months were not significant. The concentration of LH in serum (ng/ml ± SE) was .25 ± .059 in May, too low to be detected in June and July, and was 1.20 ± 0.397 in August. During the estrous cycle the concentration of LH in the pituitary increased from day one to proestrus, while the level in serum remained constantly low. The concentration of LH in the pituitary during anestrus does not seem to be directly related to the seasonal breeding of ewes. (auth)

23063 SERUM PROLACTIN LEVELS IN RATS DURING DIFFERENT REPRODUCTIVE STATES. Amenomori, Y.; Chen, C. L.; Meites, J. (Michigan State Univ., East Lansing). Endocrinology; 86: 506-10(Mar 1970).

Rat serum prolactin as determined by radioimmunoassay during the estrous cycle was found to be highest during estrus (68.5 ± 7.4 ng/ml) and lowest in diestrus (27.6 ± 5.0 ng/ml). Serum prolactin levels during proestrus, estrus and metestrus were not significantly different. There were no cyclic changes in serum prolactin levels in mature male rats. Estrogen injections increased both pituitary and serum prolactin, whereas ovariectomy decreased both. During the first three days of pregnancy, serum prolactin was higher (19.1 ± 7.4 to 30.2 ± 4.5 ng/ml) than during the following 18 days (8.3 ± 1.1 to 10.9 ± 1.2 ng/ml). On the 22nd day of pregnancy serum prolactin levels rose to 29.2 ± 13.8 ng/ml. On the 1st day post partum, serum prolactin increased to 65.5 ± 19.0 ng/ml, and a high serum concentration was maintained by the suckling stimulus for at least eight days. On the 15th and 23rd days post partum, serum prolactin fell to about half (25.7 ± 5.5 ng/ml) of the level on the first day post partum. Removal of litters from mother rats on the 4th day post partum resulted in a rapid decline in serum prolactin, reaching pregnancy levels three hr later (8.3 ± 0.1 ng/ml). When litters of 10 pups each were returned to their mothers for one-half or three hr of suckling after 12 hr of nonsuckling, serum prolactin increased precipitously to 130.3 ± 19.6 and 108.3 ± 7.8 ng/ml, respectively, and pituitary content fell sharply. Regular suckling by litters constantly with their mothers maintained high pituitary and serum prolactin levels. (auth)

23064 EFFECTS OF ESTROGEN AND PROGESTERONE ON SERUM AND PITUITARY PROLACTIN LEVELS IN OVARIECTOMIZED RATS. Chen, C. L.; Meites, J. (Michigan State Univ., East Lansing). Endocrinology; 86: 503-5(Mar 1970).

Serum and anterior pituitary (AP) prolactin levels from mature ovariectomized rats were assayed by radioimmunoassay methods after injection with daily doses of 0.1 to 500 μg estradiol benzoate (EB) or 0.5 to 10 mg progesterone for six days. Doses of 0.1, 1, or 5 μg EB increased serum prolactin concentration 2-, 3- and 10-fold, respectively, over ovariectomized controls, and doses of 10 to 500 μg EB evoked smaller increases in serum and AP prolactin levels. AP prolactin concentration and content were increased 3- to 4-fold. Doses of 0.5, 1, or 4 mg progesterone partially inhibited the increase in serum prolactin levels evoked by 1 μg EB, but only the inhibition by 4 mg progesterone was significant. A daily dose of 4 mg progesterone injected alone appeared to have no effect on serum and AP prolactin levels, but a 10 mg dose significantly increased prolactin secretion. These results indicate that low doses of estrogen are more effective than high doses for increasing AP and serum prolactin levels, and provide no evidence that large doses of estrogen can reduce AP and serum prolactin levels. They also indicate that large doses of progesterone can partially counteract the stimulating action of estrogen on AP prolactin release. (C.H.)

23065 PITUITARY-ADRENAL FUNCTION IN THE SQUIRREL MONKEY. Brown, Gregory M.; Grota, Lee J.; Penney, David P.; Reichlin, Seymour (Univ. of Rochester, N. Y.). Endocrinology; 86: 519-29(Mar 1970).

During the course of neuroendocrine investigations in squirrel monkeys base line values for plasma corticoids by radiostereoassay in excess of 400 μg/100 ml were observed. These values are higher than any reported in other mammalian species. Among possible explanations of this finding is that these animals are resistant to feedback inhibition of ACTH release, that there is an unusual circulating corticoid different from cortisol (the chief adrenal steroid found in other primates), or that there is an unusually high concentration of cortisol binding protein in this species. In order to answer these questions, studies were made of the nature of the corticoids and the capacity of corticoid binding proteins of squirrel monkey plasma, the rate of disappearance from the circulation of injected ^3H-cortisol, and the effects of capture, chair restraint, dexamethasone, and ACTH on plasma cortisol. These studies indicate that the major steroid in squirrel monkey plasma is cortisol, that the values in resting, undisturbed caged animals are indeed uniquely high (405 μg/100 ml ± SE 43), and are capable of increasing in response to capture (672 μg/100 ml ± SE 72) and chair restraint (1024 μg/100 ml ± SE 52), that the bound fraction of plasma cortisol is not greater than in other primates, that the turnover rate of cortisol is extremely high (30 mg/day in chair restrained animals), that adrenal function in these animals is inhibited only by relatively large doses of dexamethasone, and that they are relatively unresponsive to exogenous ACTH. (auth)

23066 STUDIES ON THE SITE OF ACTION OF ORAL CONTRACEPTIVE STEROIDS. II. PLASMA LH AND FSH LEVELS AFTER ADMINISTRATION OF ANTIFERTILITY STEROIDS AND LH-RELEASING HORMONE (LH-RH). Schally, Andrew V.; Parlow, Albert F.; Carter, Weldon H.; Saito, Motoi; Bowers, Cyril Y.; Arimura, Akira (Veterans Administration Hospital, New Orleans. Tulane Univ., New Orleans. Univ. of California, Torrance). Endocrinology; 86: 530-41(Mar 1970).

The effects of ovulation-inhibiting steroids on plasma LH and

FSH levels and the response to iv administration of LH-releasing hormone (LH-RH) were investigated in rats. Plasma LH levels are measured by ovarian ascorbic acid depletion (OAAD) assay and by radioimmunoassay (RIA). Plasma FSH was also measured by RIA. Subcutaneous administration of large doses of megestrol acetate, lynestrenol, Schering AG compound SH 1040 and Ayerst compound AY 11440 or of small daily doses for 5 days of combinations of megestrol acetate with ethinyl estradiol (Ovex) and lynestrenol with mestranol (Lyndiol), significantly depressed plasma LH levels in ovariectomized rats. The same compounds in large doses also depressed serum FSH levels, but small doses of Lyndiol and Ovex did not do so. Large doses of Lyndiol, Ovex, Schering AG compound SH 1040 and a combination of AY 11440 with ethinyl estradiol did not suppress the stimulatory effect of minute amounts (0.11–0.16 μg) of LH-RH on LH release (3- to 10-fold increase). Similarly, sc administration of massive doses of 1 of the following 8 contraceptive preparations: Oracon, Ovral, Ortho-Novum, Enovid, Ovulen, Provest, Norlestrin or C-Quens, depressed plasma LH to $\frac{1}{5}$–$\frac{1}{3}$ of its basal concentration and also depressed plasma FSH. However, iv administration of 0.1 μg LH-RH to these rats caused a 6- to 13-fold rise in plasma LH levels as determined by RIA. LH-RH was also active when given sc. Since the LH-RH preparation contained some FSH-releasing hormone (FSH-RH) activity, plasma FSH levels were also increased in groups treated with Oracon, Ortho-Novum, Provest and Enovid. This work again clearly demonstrates, in agreement with our previous studies, that contraceptive steroids do not block the stimulatory effect of LH-RH (and FSH-RH) and suggests that they act on the hypothalamus or on another brain center and not on the pituitary. The effects of oral administration of each 10 steroidal contraceptive preparations on plasma LH were also studied in ovariectomized rats. When Oracon, Ovral, Ortho-Novum, Enovid, Ovulen, Provest, Norlestrin, C-Quens, Lyndiol or Ovex was given daily for 5 days by gavage in corn oil or carboxymethylcellulose aqueous vehicle, the amounts required for lowering plasma LH were 10–100 times those previously found effective by sc administration. Suppression of plasma FSH was also observed after oral administration of Ovex and Lyndiol. (auth)

23067 A NEW RADIOIMMUNOLOGICAL PROCEDURE ("JUNCTION TEST") FOR THE QUANTITATIVE DETERMINATION OF HIGH-MOLECULAR WEIGHT ANTIGENS APPLIED TO TETANUS TOXIN, SERUM ALBUMIN, AND OVALBUMIN. Habermann, E. (Justus Liebig-Universitaet, Giessen, Ger.). Z. Klin. Chem. Klin. Biochem.; 8: 51-5(Jan 1970). (In German).

A new radioimmunological procedure (junction test) for the quantitative determination of high-molecular weight antigens is described. The antigen to be determined is fixed by the corresponding solid-phase-antibody; then, labeled antibody is added that can be bound by the free determinant groups of the antigen. The radioactivity of the washed solid phase is correlated with the amount of antigen initially present as solute. Potentialities and limits of the assay were demonstrated with tetanus toxin. The method is also useful for the determination of ovalbumin and heterologous serum albumin in the presence of serum. The detection limit for tetanus toxin and ovalbumin is below 0.1 ng. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 23006, 23111, 23155, 23192, 23193, 23235, 23236, 23242, 23249, 23266, 23310, 23312, and 23378.

23068 (CONF-690501–, pp 9-23) TRANSPLACENTAL MOVEMENT AND MATERNAL-FETAL ORGAN ACCRETION RATES OF SELECTED RADIOMINERALS IN GRAVID CATTLE, SHEEP, AND SWINE. Hansard, Sam L. (Univ. of Tennessee, Knoxville).

Concurrent radiochemical blood-balance studies were performed and maternal–fetal tissue concentration values were calculated following single oral and intravenous tracer doses of ^{45}Ca, ^{32}P, ^{59}Fe, ^{65}Zn, or ^{35}S to more than 300 gravid heifers, ewes, and gilts. This permitted quantitation and comparison of data on placental types, rate of movement from dam to fetus, and organ, tissue, and whole-body deposition of retained radioactivity as a function of gestation age and time after ingestion or injection. In the pig, placental ^{45}Ca–^{32}P ratios approached 1; 80% of that absorbed was retained by the gravid gilt at parturition, whereas 95% of the ^{65}Zn and 91% of the absorbed ^{35}S were deposited in the maternal body. Transplacental movement of ^{45}Ca was twice that for ^{65}Zn and ultimately six times more ^{45}Ca and 400 times more total calcium than zinc was deposited in third-trimester fetuses. Placental concentrations of ^{59}Fe, ^{65}Zn, and ^{35}S were higher than of ^{45}Ca or ^{32}P, and ^{45}Ca disappearance rates for placenta and fluids averaged less than for fetal calcium accretion (0.346 vs. 0.867%/hr). Data suggested limited importance of the placenta as a source of fetal calcium. Maternal-organ concentration for most isotopes peaked before 24 hr following administration, whereas fetal-liver radionuclide levels continued to increase beyond 168 hr. Peak concentrations for kidney, heart, spleen, and adrenals occurred earlier and were less clear cut, but the patterns were similar. Calculated partition of ^{65}Zn in third-trimester ruminants and gilts showed 86 and 47%, respectively, to be deposited in the placental complex, but little difference was observed in the percentage deposited during 168 hr in the developing fetus (52%), suggesting placental retention to be the limiting factor in net transplacental movement. Relations to placental-membrane permeability, fetal mineral nutrition, and radiation-dose calculations are discussed. (auth)

23069 (CONF-690501–, pp 25-44) IRON TRANSFER BY THE FETO-PLACENTAL UNIT OF THE RAT. Glasser, Stanley R.; McKee, L. Clifford Jr.; Heyssel, Robert M. (Vanderbilt Univ., Nashville, Tenn.).

The rate of accumulation and distribution of ^{59}Fe in the fetus and placental structures was studied at different stages of gestation in the rat. There was a progressive increase in the percent of ^{59}Fe and in the total amount of iron transferred to the fetus through day 18. After day 16, the greatest fraction of ^{59}Fe cleared from the maternal circulation by each feto-placental unit (FPU) was taken up by the fetus. The fetal liver was the primary receptor during the period of most marked increase in transfer (days 14 and 16). These changes occurred despite rapidly decreasing maternal serum iron values. Maternal anoxia increased fetal iron concentration and amount while lowering the hematocrit. In addition, reduction in xanthine oxidase activity by use of an inhibitor, allopurinol, failed to alter maternal–fetal iron exchange. Placental uptake of ^{59}Fe following fetectomy at day 16 and thereafter was equal to or greater than that of the entire FPU, suggesting that the placental system for extracting iron from the maternal circulation and its retention is separable from and not dependent on the fetal receptor mechanism. (auth)

23070 (CONF-690501–, pp 97-104) COMPARATIVE TRANSFER OF CALCIUM AND STRONTIUM AND OF POTASSIUM AND CESIUM IN THE GUINEA PIG PLACENTA. Twardock, A. R.; Downey, H. F.; Kirk, E. S.; Austin, M. K. (Univ. of Illinois, Urbana).

The fetal circulation of the guinea pig placenta was perfused in situ with guinea pig plasma, and the transfer of radionuclides injected intravenously or intraperitoneally into the intact maternal circulation was observed. Discrimination against strontium in favor of calcium was observed in the perfused placenta; the observed ratio (O.R.) of perfusate to maternal plasma averaged 0.58 for 35 perfusions and ranged from 0.45 to 0.65. The O. R. was not affected when perfusate calcium was increased or decreased with respect to the normal concentration of approximately 10 mg/100 ml. Discrimination against strontium in favor of calcium passing from dam to fetus is apparently a function of the placental membrane, does not require the presence of the fetus, and is not affected by large changes in the perfusate calcium concentration. Placental discrimination against cesium in favor of potassium was also observed. In the intact fetus–dam at 12 to 18 hr after intraperitoneal injection, the O. R. of fetus to maternal plasma ranged from 0.20 to 0.38 in 12 fetuses from four dams. In seven perfused placentas, the O. R. of perfusate to maternal plasma ranged from 0.38 to 0.76. (auth)

23071 (CONF-690501–, pp 117-20) MATERIAL-FETAL TRANSFER OF INJECTED ^{137}Cs AND ^{131}I IN DEER AND SHEEP. Della Rosa, R. J.; Book, S. A.; Wolf, H. G.; Longhurst, W. M. (California Univ., Davis).

Four pregnant sheep (Ovis aries) and three pregnant deer (Odocoileus hemionus columbianus) in the latter third of gestation were intravenously injected with about 50 μCi of ^{131}I and about 15 μCi of ^{137}Cs. Blood samples were taken 11 times over the next 48 hr to determine plasma disappearance rates; the animals were then sacrificed, and determinations of radionuclide distribution in maternal and fetal tissues were made. Radionuclide content in tissue samples was determined by differential γ-ray spectrometry using a 20- by 10-cm NaI(Tl) crystal and a multichannel analyzer. An automatic γ-well counter was used for determinations of radionuclide content in blood (plasma) samples. Percentage of administered dose was determined by spectrum stripping and computer analysis of the data. (auth)

23072 (CONF-690501–, pp 121-35) CROSS-PLACENTAL PASSAGE OF ^{228}Ra AND ITS DAUGHTERS AFTER INTRAVENOUS INJECTION OF COLLOIDAL THORIUM DIOXIDE (THOROTRAST) INTO RABBITS. Einck-Rosskamp, P.; Stahlhofen, W. (Gesellschaft fuer Strahlenforschung, m.b.H., Frankfurt am Main, W. Ger.); Rajewsky, B. (Max Planck-Institut fuer Biophysik, Frankfurt am Main, W. Ger).

Thorotrast, formerly used in radiography as a contrast medium, contains considerable ^{232}Th. The major fraction of the ^{232}Th is deposited in the reticuloendothelial system (RES) soon after an intravenous injection. Radium-228 and its daughters, which arise from the ^{232}Th, are present in the bloodstream after injection and are excreted or translocated into other organs. Mature female rabbits injected with Thorotrast at different times before and after copulation were sacrificed at different times of pregnancy. The whole fetal envelopes, including the placentas and the fetuses, were withdrawn carefully from the extirpated and opened uterus. The fetuses, placentas, blood, and several organs of the dam were analyzed for ^{232}Th daughters by following the growth and decay of the x-ray intensity of the ^{228}Ac and ^{208}Tl using scintillation detectors connected with a multichannel analyzer. Approximately 0.01% of the injected activity could be detected in the tissue preparations by the techniques employed. It is shown that the developing fetuses accumulate more radium than the dam's muscle tissue. The apparent ^{212}Pb transfer is supposed to be due to an easy transition of the noble gas ^{220}Rn. (auth)

23073 (CONF-690501–, pp 137-43) THE EFFECT OF SELENIUM COMPOUNDS ON THE CROSS-PLACENTAL PASSAGE OF ^{203}Hg. Parizek, J.; Babicky, A.; Ostadalova, Ivana; Kalouskova, Jana; Pavlik, L. (Czechoslovak Academy of Sciences, Prague).

The administration of a small amount of selenite to pregnant rats injected with a tracer dose of ^{203}Hg-labeled mercuric chloride increased the retention of mercury in the maternal organism but markedly decreased the passage of ^{203}Hg from the mothers into the fetuses. In spite of the fact that the level of ^{203}Hg in maternal blood and blood plasma was markedly increased in rats treated by selenite, the concentration of ^{203}Hg in whole fetuses of these rats, as well as in the blood and the liver of these fetuses, was significantly lower than in fetuses of control animals. Administration of selenite did not result in a significant change in ^{203}Hg content in the placenta; however, selenite significantly increased the ^{203}Hg concentration in maternal liver and decreased ^{203}Hg concentration in maternal kidneys. The administration of an equimolar amount of sodium sulphite did not have an effect similar to that of selenite. (auth)

23074 (CONF-690501–, pp 153-60) EXPERIMENTAL STUDY OF RADIONUCLIDE TRANSFER THROUGH THE PLACENTA AND THEIR BIOLOGICAL ACTION ON THE FETUS. Moskalev, J. I.; Buldakov, L. A.; Lyaginskaya, A. M.; Ovcharenko, E. P.; Egorova, T. M. (Ministry of Public Health, Moscow).

Levels of radionuclide transferred to the fetus and radionuclide retention in the placenta depend on the chemical characteristics of the nuclide and the period of pregnancy. The placental transfer of all nuclides increased between midterm (11 to 15 days of gestation) and the end of pregnancy. The ratios of the nuclide transferred toward term to that transferred earlier were ^{239}Pu, 1.7; ^{241}Am, 2.8 to 4.5; ^{137}Cs, HTO, and ^{237}Np, 5; ^{90}Sr, 20; and ^{131}I, 1700 to 6000. The content of transuranic elements in the placenta at all periods of pregnancy was 3 to 15 times higher than in the fetuses. Radioinduced changes in the embryo depend on the amount of activity injected, the distribution pattern, and the physical properties of the radionuclide. The most characteristic changes associated with the various radionuclides are: ^{90}Sr, a decrease in the transfer of nuclide from placenta to fetus; ^{241}Am, earlier induction of radiation disorders in the placenta than in the fetus; ^{131}I, occurrence of radioinduced embryopathy depends on the production of disorders in the mother's thyroid; HTO, generalized vascular changes in the mothers and fetuses. (auth)

23075 (CONF-690501–, pp 163-71) ACCUMULATION OF ENVIRONMENTAL ^{90}Sr IN TEETH OF CHILDREN. Rosenthal, Harold L. (Washington Univ., St. Louis).

Accumulation of environmental ^{90}Sr in deciduous and permanent tooth crowns of American children was studied during neonatal development, infancy, and early adolescence. Teeth were selected for study because they represent a stable calcified tissue in which rates of turnover, exchange, remodeling, and accretion are minimal or absent. They reflect, therefore, the nuclide equilibrium with the body constituents at the time of tooth crown calcification. In the fetus, during the last trimester of development, the nuclide is equally distributed in tooth buds, mandibular bone, and femur and represents the contribution of the mother's diet and body burden to the developing fetus. The ^{90}Sr content of deciduous teeth of infants who were bottle fed from birth represents the small fraction incorporated in utero plus the amount obtained from the diet during the first 6 to 9 months after birth. The crown of sound permanent bicuspids begins to calcify at 1.5 yr of age with the mid-point of development occurring at age 5. The ^{90}Sr content of these teeth represents the incorporation of dietary milk nuclide during late infancy and is not influenced by the maternal in utero contribution. The assumptions inherent in the development of the equations with respect to discrimination factors, time of development of the tooth crown, and estimations of dietary ^{90}Sr intakes are discussed. (auth)

23076 (CONF-690501–, pp 173-82) ^{85}Sr RETENTION IN NEONATAL SWINE: EFFECT OF REARING ON THE SOW VERSUS SEPARATION FROM THE SOW. Anderson, J. J. B.; Crackel, W. C. (Univ. of Illinois, Urbana).

From two newborn swine litters, half of the piglets were separated from the sow and raised on an artificial ration, and the other half were kept on the sow. The retention of ^{85}Sr in the piglets raised away from the sow was not significantly different from the retention in piglets on the sow as long as the dietary calcium and phosphorus intake was the same. Retention up to 200 days postinjection was higher in piglets fed the lower recommended levels of calcium and phosphorus than when fed a ration containing 1.2% calcium and 0.8% phosphorus. This finding is in agreement with other reports. The retention data were best described by a two-exponential function. (auth)

23077 (CONF-690501–, pp 183-90) COMPARATIVE UTILIZATION OF DIETARY ^{226}Ra AND OTHER ALKALINE EARTHS BY PIGS AND SHEEP. Hardy, E.; Rivera, J.; Fisenne, I. (New York Operations Office, N. Y.); Pond, W.; Hogue, D. (Cornell Univ., Ithaca, N. Y.).

Skeletal and soft-tissue burdens of the alkaline-earth elements (Mg, Sr, Ba, and ^{226}Ra), including ^{90}Sr, were measured in pigs and sheep at various stages of growth. Intakes of these same nuclides by the pigs from birth to 177 days and by the sheep from about 155 to 285 days were also measured. The pigs received only milk during the first 6 weeks, after which they were fed the same dry feed and deionized water as were the sheep during the controlled period. Marked species differences were observed in the extent to which the pigs and sheep utilized the alkaline earths from their diet. From birth to maturity, the pigs used the following percentages of their dietary allowances: 47% Ca, 6.5% Sr, 1.0% Ba, and 0.5% Ra; the sheep during the controlled period used 17% Ca, 7.8% Sr, 11.0% Ba, and 9.2% Ra. Less than half of the pig radium burden at 117 days was in the skeleton, and 97% of the sheep radium burden was confined to the skeleton. Essentially all the ^{226}Ra in the milk consumed by the pig was utilized. Although humans and lower animals absorb and retain calcium in preference to strontium, the physiological factors involved in this discrimination between two chemically similar elements are not well understood. By studying the comparative uptake and retention of the alkaline-earth elements in a ruminant and nonruminant animal, we have gained information that may further our understanding of comparative alkaline-earth metabolism in man. (auth)

23078 (CONF-690501–, pp 191-205) DEPENDENCE OF ^{137}Cs RETENTION ON AGE IN THE FETAL AND JUVENILE BEAGLE DOG. Tyler, Sylvanus A.; Kretz, Norbert D.; Norris, William P. (Argonne National Lab., Ill.).

Cesium-137 retention at various times after injection was determined for individual dogs ranging from 61 to 588 days of age at injection. Constants of the model, derived from a least-squares fit of the data, reveal that the specific rate of change of retention is a continuously decreasing function of age and is not influenced by the particular age at injection. A new descriptive model of ^{137}Cs retention in the juvenile dog, that demonstrates a high correlation between ^{137}Cs retention and growth (weight), is presented. By utilizing this correlation, the time course of ^{137}Cs retention in the fetal dog is projected. (auth)

23079 (CONF-690501–, pp 207-16) AGE-RELATED DIFFERENCES IN ZINC METABOLISM IN THE RAT. Erdman, H. E.; Mahlum, D. D.; Sikov, M. R. (Battelle Memorial Inst., Richland, Wash.).

Newborn, weanling, and adult rats were injected intraperitoneally with 0.5 μCi of ^{65}Zn, and retention was determined by whole-body counting. During the first 20 days of life, ^{65}Zn was retained most tenaciously by the animals injected at birth. Additional treated rats were sacrificed 1, 5, or 9 days after injection, and the ^{65}Zn content of various tissues was determined. Total tissue content was calculated as the percent of total-body content at the time of sacrifice. In the newborns and weanlings, the skeleton had the greatest concentration of ^{65}Zn, but in the adults the highest concentrations were initially deposited in the liver and muscle. In further experiments, zinc binding by liver, muscle, bone and kidney of the rat was determined in an attempt to explain the preceding results. Zinc pools in the three age groups were labeled by intraperitoneal injection of ^{65}Zn. Newborns received 10 μCi; weanlings and adults received 100 μCi. Rats were killed 3 hr and 1, 5, and 8 days after injection; soft tissues were homog-

enized, and femurs were cut in thirds. Tissues were dialyzed against four successive 100-ml portions of 0.001 M EDTA in 0.05 M Tris·HCl buffer of pH 7.4. Zinc pools of newborns were more easily depleted than those of weanlings or adults. In most cases weanling and adult zinc pools behaved comparably, although there was a tendency for adult tissues to retain zinc more tenaciously. In general, the nondialyzable fraction in soft tissues at 1 to 8 days after injection was approximately two to three times greater than that at 3 hr. The dialyzable ^{65}Zn in bone was consistently low in all age groups. (auth)

23080 (CONF-690501–, pp 217-26) SOME SPECIAL FEATURES OF NUCLIDE METABOLISM IN JUVENILE MAMMALS. Matsusaka, N.; Inaba, J.; Ichikawa, R. (National Institute of Radiological Sciences, Chiba, Japan); Ikeda, M.; Ohkubo, Y. (Tokyo Univ., Japan).

The effect of age on the gastrointestinal absorption of ^{144}Ce was determined in mice over a range of 0 to 21 days of age. Although only a small percentage of that administered was absorbed from the gut in the adult animal, a substantial absorption of ^{144}Ce was found in the neonate; 60% and 25% of doses given orally to mice that were 0 and 7 days old, respectively, were measurable in their bodies 3 weeks after administration. The similar tendency of accelerated intestinal absorption was observed for ^{106}Ru and ^{95}Zr–^{95}Nb. Therefore, it is suggested that even nuclides that were considered to be poorly absorbed, may be absorbed and incorporated to a considerable extent by suckling animals. (auth)

23081 (CONF-690501–, pp 517-27) ACUTE TOXIC EFFECTS OF ^{90}Sr IN NEWBORN RATS. Hopkins, B. J. H. (Rochester Univ., N. Y.).

Rats of the Long-Evans strain were given an intraperitoneal dose of ^{90}Sr on the second day following birth. A total of 112 experimental animals received 2.0 μCi of ^{90}Sr per gram of body weight, and 68 controls received an injection of acidified sodium chloride solution. The retention of strontium and the growth, survival, and pathological changes in the skeleton were measured during the neonatal period. The strontium-treated animals retained 91% of the injected dose at 30 days following administration. At this time, 72% of the control rats were alive compared with 67% of the strontium-treated animals. When compared with controls, the strontium-treated animals showed severe retardation of growth, neuromuscular disturbances, and pathological changes in the skeleton. These data showed that the dose administered was extremely toxic and provided information on the mechanisms of the toxic effects of radioactive strontium. (auth)

23082 (CONF-690501–, pp 529-41) METABOLISM AND TOXICITY OF ^{90}Sr IN THE IMMATURE BEAGLE. Della Rosa, R. J.; McKelvie, D. H.; Goldman, M.; Rosenblatt, L. S. (California Univ., Davis).

Some metabolic factors associated with the uniform labeling of bone of immature beagles fed a daily diet containing 10 μCi of ^{90}Sr per gram of calcium from midgestation to 150 and 540 days of age are summarized. The placental and mammary barriers reduced the ^{90}Sr/Ca ratio, which changed rapidly when the pups were weaned. At birth the labeled skeletal ^{90}Sr/Ca ratio was 0.1 that of the diet, 0.2 during the suckling period, and 0.4 following weaning to the solid diet. The daily intake at this time was about 30 μCi of ^{90}Sr. Whole-body monitoring of ^{90}Sr + ^{90}Y bremsstrahlung and estimates of skeletal mass were used in computing bone doses. The cumulative dose to the skeleton from birth to 150 days of age, allowing for a lower dose rate prior to weaning, was estimated to be approximately 2000 rads. By 100 days of age, the dose rate was about 20 rads/day and was determined to be a function of the accretion of strontium and calcium and of the increased absorption of beta energy from skeletally deposited ^{90}Sr + ^{90}Y. At 150 days of age, the body burden in the pups approximated 300 μCi (0.5 μCi/g bone). Microradiographic examination revealed cortical thickening, decreased size of medullary cavities, a decrease in percentage of remodeling osteons, and an increase in bone density. Continuous β irradiation during bone formation may, in part, cause a greater depression of osteoclastic than osteoblastic activity. A severe depression (>50%) in total leukocytes was observed at 150 days of age; the neutrophil concentration was depressed to one-third that of controls and remained at this low level for the duration of the feeding period. (auth)

23083 (CONF-690501–, pp 543-65) PATHOLOGIC CONSEQUENCES OF RADIOSTRONTIUM ADMINISTERED TO FETAL AND INFANT DOGS. Finkel, Miriam P.; Biskis, Birute O. (Argonne National Lab., Ill.).

Five fetal and two infant dogs were treated with radiostrontium (80 to 99% ^{89}Sr, 1 to 20% ^{90}Sr) to provide information on the sensitivity of very young animals to internal irradiation. The concentration of radiostrontium at birth among the dogs treated in utero was 1.33 mCi/kg. This amount was not acutely lethal, did not produce severe hematologic disease, and did not cause bone cancer; it did, however, result in abnormal skeletal growth. The two dogs treated at 12 and 14 days of age with 0.52 and 0.46 mCi/kg, respectively, died with osteosarcoma 2.3 and 8.7 yr later. Since the $LD_{50/30}$ of ^{89}Sr for adult dogs is 1.0 mCi/kg, and since two out of five adults treated with 0.3 and 1.0 mCi/kg died with osteosarcoma, these data indicate that the very young dog is not more sensitive than the adult to either the lethal effect or the oncogenic effect of radiostrontium. (auth)

23084 (CONF-690501–, pp 567-76) SKELETAL CHANGES PRODUCED BY THE ADMINISTRATION OF ^{239}Pu AND ^{144}Ce TO WEANLING RATS. Mahlum, D. D.; Sikov, M. R. (Battelle Memorial Inst., Richland, Wash.).

Newborn, weanling, and adult rats were injected intravenously with from 6 to 90 μCi/kg body weight of monomeric or polymeric ^{239}Pu. Subjective observation at 30 days after exposure indicated increased fragility of the skeleton in animals injected as weanlings with the higher doses of monomeric ^{239}Pu but not in those injected with polymer. At 90 days after injection of weanling rats with 60 μCi/kg of monomeric ^{239}Pu, it was observed that their femurs had undergone spontaneous fracture, followed by abnormal healing and callous formation. Histologic examination showed disorganization of the cartilage accompanied by abnormal calcification in the epiphyseal area. There was a dose-dependent decrease in breaking strength of excised femurs from animals exposed as weanlings; alterations were less marked in femurs from rats exposed to similar doses as newborns or adults. Quantitative alterations in such constituents as water and in minerals other than calcium and phosphorus were found in weanlings that received ^{239}Pu. In a similar experiment, 0.25, 0.5, or 1.0 μCi/g of ^{144}Ce was injected into newborn, weanling, and adult rats. At approximately 6 months postinjection, tumors could be palpated on the legs of many of the rats that received 1 μCi/g as weanlings; histologic examination showed these to be osteosarcomas. Radiographic examination disclosed that approximately 50% of the rats of this group had skeletal tumors. Gross and radiographic examination of animals exposed as adults to the same dose of ^{144}Ce showed no tumor development. However, a number that received the intermediate dose (0.5 μCi/g) as adults subsequently developed osteosarcomas. (auth)

23085 (COO–1744-2) UPTAKE, EXCRETION, AND DISTRIBUTION OF ^{65}Zn BY THE MALLARD. Final Progress Report, July 1, 1967–September 14, 1969. Glover, F. A.; Curnow, R. D. (Colorado Cooperative Wildlife Research Unit, Fort Collins). Mar 1970. Contract AT(11-1)-1744. 68p. Dep. CFSTI.

Experiments were conducted to determine ^{65}Zn uptake and retention parameters in the mallard duck. Statistical analyses were performed to determine the influence of mallard age and sex, egg production, feather molt and the season of the year on ^{65}Zn kinetics in the mallard. Egg production was an important mechanism of zinc extretion, accounting for a loss of about 25 percent of the injected dose. The average egg contained 0.7 percent of the injected ^{65}Zn with essentially all of the radiozinc being associated with the egg yolk. The effective half-time of ^{65}Zn in ovulating mallards was 27.6 days. Season of year, but not the age or sex of the mallard, was a major factor influencing ^{65}Zn absorption from an oral dose. In the fall trial, 16 percent of an oral dose was absorbed through the gastrointestinal tract; while in the spring, 37 percent was absorbed. Retention of ^{65}Zn was influenced by season of year and sex. But age of the adult ducks (5 mo. and 17 mo.) did not affect retention. Retention was greater in the fall in both sexes. Male mallards retained ^{65}Zn more tenaciously than did females. Radiozinc incorporated into growing feathers of mallards following the annual feather molt accounted for 4.7 percent and 2.3 percent of the injected dose in male and female adult mallards, respectively. Following a 6-hour bath in water containing ^{65}Zn, 88.5% of the mallard total body activity was associated with the feathers. Only 11.5 percent of the total body activity was due to ingested radiozinc. It appeared that feathers can adsorb or absorb ^{65}Zn present in the water used by the duck for dabbling, resting, and feeding. (auth)

23086 (IN–1345) PERMEATION OF IODINE THROUGH HUMAN EPIDERMIS. Clark, J. L.; Nichols, C. E.; Cartan, F. O. (Idaho Nuclear Corp., Idaho Falls). Feb 1970. Contract AT(10-1)-1230. 13p. Dep. CFSTI.

Measurements of the rate at which iodine permeates through human epidermis show that the mechanism involved is not simple diffusion. The apparent vapor permeability is far too large and is a function of the exposure period. These measurements show that the human epidermis will pass significant amounts of radioiodine. The apparent vapor permeability constants, measured after an initial 30 minute exposure, range from 0.08 to 17.8 cm/

min. The measurements show that a reservoir of iodine is created in the skin during an exposure to iodine vapor. Unless removed, it serves as a source for continued iodine permeation even after the vapor exposure is stopped. The chemical species of iodine which actually penetrates the epidermis is water soluble and not appreciably volatile. This rules out species such as elemental iodine or methyl iodide. The permeating species is probably ionic and its permeation through human skin the result of a three-step process. These steps are: first, sorption of elemental iodine at the skin surface; second, a chemical conversion of iodine to the ionic species; and third, aqueous diffusion of the ionic species through the epidermis to the circulating fluids of the dermal layer. (auth)

23087 KINETICS OF ^{47}Ca IN MAN. Jovanovic, V.; Popovic, S.; Latkovic, I.; Simonovic, I. (Inst. for Medical Research, Zagreb). Arh. Hig. Rada Toksikol.; 19: 11-23(1968).

Metabolism of ^{47}Ca was investigated in 9 healthy subjects by use of a slight modification of the Wenderberg method. The modification used was technically simpler, giving equally accurate results. The most useful data obtained were those relating to ^{47}Ca accretion in the skeleton. Though the absolute accretion rate depends to a certain extent on the method used, this parameter, when the same method is used, is, none the less, a reproducible value and can be regarded as a useful index. Kinetic analysis of ^{47}Ca also allowed the calculation of Ca body compartments, but the meaning of these data remained obscure. Owing to the modified method and perhaps to the choice of subjects, the results of the kinetic analysis of ^{47}Ca in healthy persons obtained in this study only partly agreed with the results of other authors. The following values were obtained: accretion: 0.57 ± 0.12 g Ca/day, S compartment: 2.10 ± 0.32 g Ca and E compartment: 2.86 ± 0.83 g Ca. (BBB)

23088 THE EFFECT OF PHOSPHATES ON STRONTIUM AND CALCIUM METABOLISM IN CONTROL, PARATHYROIDECTOMIZED, AND PARATHORMONE-TREATED RATS. Gruden, Nevenka; Rabadija, L.; Kostial, Krista (Inst. for Medical Research, Zagreb). Arh. Hig. Rada Toksikol.; 19: 25-32(1968).

The influence of the phosphate content of the diet on ^{85}Sr, ^{45}Ca, and ^{47}Ca metabolism was studied in control, parathyroidectomized, and parathormone-treated rats after oral and intraperitoneal administration of the radioisotopes. Female rats, 8 to 9 weeks old, on the experimental diets for 8 days, received a dose of 0.01 μCi ^{45}Ca or ^{47}Ca and 0.2 μCi ^{85}Sr. On the 16th day all animals were sacrificed, and skeletal retention of radioisotopes was estimated in the femora. Results showed that skeletal retention of ^{45,47}Ca and ^{85}Sr and the ^{85}Sr/^{45,47}Ca ratio depend upon the phosphate content in the diet as well as upon the route of radioisotope administration. The effect of phosphate on Ca and Sr metabolism, however, does not depend upon the function of the parathyroid gland. In parathyroidectomized, parathormone-treated, and control rats both the urinary elimination and gastrointestinal absorption of radiocalcium and radiostrontium are influenced by changes in dietary phosphates in the same way. It is likely that the binding of Ca and Sr by phosphates and other physico-chemical factors regulating the mineral equilibrium in the body are responsible for this action of phosphate, rather than an effect mediated by the parathyroid gland. (BBB)

23089 APPLICATIONS OF ISOTOPES TO THE STUDY OF SOIL-PLANT RELATIONSHIPS. Barbier, G. (CEN, Cadarache, France). Bull. Inform. Sci. Tech. (Paris); No. 141, 21-30(Oct 1969). (In French).

A bibliographical review is presented on the use of isotopes in agronomy research in France. It is observed that ^{15}N is little used in spite of the fact that anomalies in the nitrogen cycle in cultivated soils cannot be explained. The study of isotopic exchanges of phosphorus in the soil contributed substantially to the problem of the reversibility of phosphate fixation in the soil. Studies on organic-inorganic soil complexes were greatly facilitated by the use of radioisotopes. (auth)

23090 USE OF NUCLEAR LABELS IN PLANT PHYSIOLOGY AND PHYTOTECHNOLOGY. Berlier, Y. (CEN, Cadarache, France). Bull. Inform. Sci. Tech. (Paris); No. 141, 31-43(Oct 1969). (In French).

The use of radioactive or stable isotopes in various fields of phytotechnology and plant physiology is reviewed briefly. These tracers are involved in the study of all stages of plant nutrition, from the absorption and transport of inorganic elements through the roots, where the importance of exchanges has been demonstrated, to metabolic transformations and biosyntheses, photosynthesis in particular, which it has been possible to study in detail owing to the use of labeled precursors. The combined use of different nuclear tracers, isotopic activity measurement techniques and autoradiography has enabled all these processes to be accurately localized and followed quantitatively as a function of the element studied, and of external or internal parameters acting positively or negatively on the physiology of the plant. (auth)

23091 RESIN UPTAKE TEST AND IODIDE IMPURITY OF ^{131}I-LABELED THYROID HORMONES. Clark, F.; Brown, H. J.; Groette, G. J. (Univ. of Newcastle upon Tyne, Eng.). J. Nucl. Med.; 11: 165-72(Apr 1970).

The ^{131}I-labeled thyroid hormones (l-thyroxine and 3,5,3'-l-triiodothyronine) are known to contain variable amounts of contaminant, particularly radioiodide. Furthermore, different batches of the hormones give different resin uptake values. It was considered that these two factors could be related. A study of the problem showed the variability of degree of iodide contamination and of resin uptake, and also revealed that there was a close correlation between degree of iodide contamination and resin uptake from serum. However, when iodide was removed by gel filtration, the subsequent resin uptake, although diminished overall, still varied considerably between batches of hormone (except in one series of estimations) which indicated that additional factors, possibly other radioiodinated contaminants, not removed by the preparatory steps used, were also important. An overall similarity in resin uptake results from two different techniques, although one gave improved reproducibility, was also shown, and the prior finding that resin particle size played a significant role in uptake values was confirmed. (auth)

23092 COMPARATIVE MORPHOLOGIC AND FUNCTIONAL STUDIES OF NEPTUNIUM-INDUCED FATTY LIVERS IN RATS. Berlin, J. D.; Mahlum, D. D. (Battelle-Northwest, Richland, Wash.). Lab. Invest.; 22: 252-9(Mar 1970).

The effect of neptunium-237 on rat liver was studied by using electron microscopic techniques. Crescent-shaped dilations of the endoplasmic reticulum were the earliest morphologic alterations observed and were found 2 hours after ^{237}Np administration. By 24 hours postinjection large quantities of lipid were observed under the electron microscope. The one type was electron-transparent and was associated only with the endoplasmic reticulum; the other was electron-opaque and was associated with both the endoplasmic and the Golgi complex. Glucose 6-phosphatase, found within the cisternae of the endoplasmic reticulum in control liver, was displaced in animals treated with ^{237}Np. Treatment of the rats with butylated hydroxytoluene before ^{237}Np injection prevented the displacement of glucose 6-phosphatase. (auth)

23093 REINGESTION OF FECES AND EXCRETION RATES OF ^{65}Zn IN POPILIUS DISJUNCTUS VERSUS CRYPTOCERCUS PUNCTULATUS. Burnett, Alta M.; Mason, W. H.; Rhodes, S. T. (Auburn Univ., Ala.). Ecology; 50: 1094-6(Autumn 1969).

Oxygen consumption and ^{65}Zn excretion were measured at temperatures of 17°C and 27°C for two similar-sized species of wood-feeding insects, Cryptocercus punctulatus and Popilius disjunctus. In each species, rate of oxygen consumption was approximately doubled, and ^{65}Zn excretion was significantly accelerated at the higher temperature. In animals held at a given temperature, μl O_2 consumed/gm live body weight was similar. However, radiozinc excretion was much more rapid in P. disjunctus than in C. punctulatus at each temperature. The species differences in ^{65}Zn excretion may reflect the extreme differences in feeding habits of these otherwise ecologically similar inhabitants of decaying logs. Excretion rate of ^{65}Zn seems to be a good index of metabolic activity and may be of promise in the study of trophic relationships. (auth)

23094 ^{131}I CONCENTRATION IN SUBMAXILLARY GLANDS AND OTHER TISSUES OF RATS. Esposito, E. J. (Walter Reed Army Medical Center, Washington, D. C.). J. Dent. Res.; 49: 459(Mar-Apr 1970).

Twenty-five rats were injected intraperitoneally with ^{131}I, and 25 were injected with ^{86}Rb. Rats were killed at intervals up to 4 hrs after administration of the isotopes and counts were made on salivary glands, muscles, brain, and kidneys. Linear plots of results indicated that uptakes for each isotope were in the same decreasing order: kidney, submaxillary gland, muscle, and brain. The results indicated an extreme affinity of the submaxillary glands for ^{131}I. (H.L.W.)

23095 PREFERENTIAL LOCALIZATION OF ^{67}Ga CITRATE IN TISSUES OF LEUKEMIC MICE. Swartzendruber, D. C.; Byrd, B. L.; Hayes, R. L.; Nelson, B.; Tyndall, R. L. (Oak Ridge Associated Universities, Tenn. Oak Ridge National Lab., Tenn.). J. Nat. Cancer Inst.; 44: 695-700(Mar 1970).

The 24-hour concentration of gallium-67 (^{67}Ga) citrate in vari-

ous tissues of leukemic and nonleukemic mice is reported. Significantly higher concentrations of ^{67}Ga localized in the thymus and involved lymph nodes of leukemic AKR/J mice than in nonleukemic AKR/J mice. ^{67}Ga localized more in thymic tissue of young (7 weeks) AKR/J mice than in older (3-10 months) nonleukemic AKR/J mice. Although spleens of leukemic AKR/J mice often contained histologically typical lymphoma cells, the ^{67}Ga concentration did not increase in this organ. Concentrations of ^{67}Ga also increased in blood, spleen, liver, and lungs of BALB/c mice with leukemia induced by Rauscher virus. Gallium is a bone-seeking element; the mechanism of its localization in tumor tissue as yet is unknown. (auth)

23096 EFFECT OF DIETARY SODIUM ALGINATE ON RADIOSTRONTIUM ABSORPTION AND RETENTION IN RATS. Light, James M.; Stookey, George K.; Muhler, Joseph C. (Indiana Univ., Indianapolis). J. Dent. Res.; 49: 442-53(Mar-Apr 1970).

Sodium alginate reduced intestinal absorption of radiostrontium and increased its fecal elimination. Skeletal retention also was reduced. (auth)

23097 THE INTERACTION OF ^{99}Mo WITH BIOCOMPONENTS OF THE SKIN. Shvydko, N. S.; Il'in, L. A.; Norets, T. A.; Antonova, V. A. (Inst. of Research in Radiation Protection, Leningrad). Med. Radiol.; 15: No. 2, 58-64(Feb 1970). (In Russian).

Data characterizing the fixation of ^{99}Mo by individual biocomponents of the skin, as well as the epidermis, derma, and subcutaneous cellular tissue are presented. The quantitative distribution of ^{99}Mo between fat-soluble, water-soluble, and residual fractions of the skin and its layers is demonstrated. The mechanisms of fixation of ^{99}Mo by different structures of the tissue are discussed. (auth)

23098 CLEARANCE OF THOROTRAST, A DEXTRIN STABILIZED COLLOID. Muller, T. (Finsenlab., Finseninst., Copenhagen). Acta Pharmacol. Toxicol.; 26: 491-500(1968).

The initial part of the clearance curve (Thorotrast) after i.v. injection of doses between 1 and 3.5 ml/kg into rabbits was studied. An unexpected primary phase with an extremely low rate of clearance was demonstrated with a duration dependent on the amount injected. No blocking of the reticuloendothelial system could be demonstrated. Most of the dextrin is removed soon after injection without the corresponding amount of thorium dioxide. As dextrin is the only stabilizing agent in Thorotrast, there seems to be a threshold value for dextrin in the blood that protects the colloid from being phagocytized. (Excerpta Med.)

23099 EFFECTS OF DECENYLSUCCINIC ACID ON ^{32}P UPTAKE AND TRANSLOCATION BY BARLEY AND WINTER WHEAT. Green, D. G.; Ferguson, W. S.; Warder, F. G. (Canada Agriculture, Swift Current, Saskatchewan). Plant Physiol.; 45: 1-3 (Jan 1970).

After 3 days of exposure to 10^{-3} and 10^{-4}M decenylsuccinic acid, winter wheat plants wilted and died. Decenylsuccinate at 10^{-3}M inhibited ^{32}P uptake by barley roots and wheat roots and resulted in significant ($P \leq 0.05$) leakage of previously absorbed ^{32}P and total phosphorus (barley roots). Decenylsuccinate effects on ^{32}P uptake and retention were attributed to increased permeability resulting from injury. Decenylsuccinate at 10^{-4}M did not inhibit root uptake of ^{32}P but decreased movement into the shoot. This could be interpreted as an indication of reduced transpiration or inhibition of ^{32}P loading into the transpiration stream. Decenylsuccinate did not increase cold hardiness in winter wheat in a nonhardening environment. (auth)

23100 ACTIVITY EMITTED WITH THE EXPIRED AIR BY PATIENTS SUBJECTED TO ENDOLYMPHATIC RADIOTHERAPY. De Vecchi, A.; Bertoli, M. A.; Fava, G.; Guindani, A.; Prada, A.; Mazzola, G. (Univ., Milan, Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Med. Nucl.-Radiobiol. Lat.; 11: 329-40(1968).

A study was made of the elimination of activity with the expired air in nine patients subjected to endolymphatic radiotherapy with ^{131}I-Lipiodol. Counts were made of the activity eliminated and these were compared with those of the activity eliminated by other routes and with the distribution and metabolism of ^{131}I-Lipiodol in the body. Explanations for the findings are suggested. (auth)

23101 EXCRETION OF RADIOCESIUM (^{137}Cs) IN SWEAT FROM HUMANS. Vellar, Odd D. (Univ. of Oslo); Madshus, Kjell. Z. Naturforsch.; 25b: 213-16(Feb 1970).

Sweat from the whole-body was collected for five healthy unacclimatized male subjects during two consecutive periods of profuse sweating in a climatic chamber with a hot humid environment. In each subject one sweat collection experiment was performed before and another experiment about two weeks after an oral dose of ^{137}Cs (160 nCi). Before the intake of the ^{137}Cs oral dose the volunteers had a natural body burden in the same range as other Oslo-residents, whereas their mean body burden rose by a factor of approximately six, measured five days after the intake of the dose. The mean concentration of ^{137}Cs in whole-body sweat after the intake of the oral dose was about 10 times higher than the initial values. After the oral dose of ^{137}Cs, the amount excreted through sweating was about 30 pCi ^{137}Cs per hour. Thus, the present data show that the elimination of ^{137}Cs through sweating might be considerable during prolonged periods of profuse perspiration. Consequently, this excretory pathway should not be neglected under conditions where heat, humidity, and physical exertion pertain. There was no decrease in the concentration of ^{137}Cs in whole-body sweat from the first to the second period of sweat collection. Thus, the results give no support to the hypothesis of an internal contamination of the sweat of the initial stages of secretion. (auth)

23102 DTPA AND pH EFFECTS ON LEAF UPTAKE OF ^{59}Fe, ^{65}Zn, ^{137}Cs, ^{241}Am, AND ^{210}Pb. Wallace, A.; Hale, V. Q.; Joven, Claricia B. (Univ. of California, Los Angeles). Contract AT(11-1)-34. J. Amer. Soc. Hort. Sci.; 94: 684-6(1969).

"Washington Navel" orange leaves were immersed in solutions containing the radionuclides ^{59}Fe, ^{65}Zn, ^{137}Cs, ^{241}Am, and ^{210}Pb with and without the chelating agent DTPA (10^{-4} M), at pH varying from 2.0 to 8.0 and with and without the respective stable nuclides as carriers (10^{-4} M) except for ^{241}Am. Low pH decreased the uptake of all five radionuclides. Without carrier the uptake of ^{65}Zn increased with pH up to pH 8.0 as did uptake of ^{241}Am. The addition of carriers decreased uptake of all five radionuclides but carrier effect was least on ^{137}Cs. DTPA largely negated the effects of pH on uptake and greatly depressed uptake. (auth)

Radiation Effects

Refer also to abstracts 22667, 22699, 23336, and 23346.

23103 (CONF-690501--, pp 629-35) EFFECT OF WHOLE-BODY IRRADIATION ON $^{14}CO_2$ EXHALATION AFTER ADMINISTRATION OF ^{14}C-LABELED COMPOUNDS IN JUVENILE RATS. Glaubitt, D.; Wulff, K. (Medizinische Universitaetsklinik, Hamburg, Ger.).

Juvenile male rats (35 to 45 g) of the Wistar strain were irradiated with 800 R of x rays in a single whole-body exposure. The rats were given ^{14}C compounds at several intervals following irradiation. The air exhaled during the next 7 hr was analyzed for $^{14}CO_2$ and total CO_2 content. Parenteral administration of the ^{14}C compounds was used to study intermediary metabolism; absorption was estimated by comparing the levels of $^{14}CO_2$ exhaled after oral administration with that expired following parenteral injection. After either intragastric or intraperitoneal administration of glucose-^{14}C(U), the average specific activity of the expired air was usually increased in the irradiated rats. Irradiation caused a decrease of the average specific activity when caprylic acid-1-^{14}C, glyceryl trioleate-1-^{14}C, or glyceryl trioctanonate-1-^{14}C was administered intragastrically. (auth)

23104 (CONF-690501--, pp 823-39) SOME QUALITATIVE ASPECTS OF THE DIFFERENTIATING STRATUM GRANULOSUM IN THE POSTNATAL RAT HIPPOCAMPUS. Jones, Margaret Z. (Medical College of Virginia, Richmond); Brownson, Robert H. (California Univ., Davis).

The stratum granulosum of the three-layered dentate gyrus in the rat hippocampus completes its development during the first 30 days of postnatal life. Previous studies showed that only the cells in the deep stratum granulosum remained undifferentiated and showed selective radionecrosis at 15 days after birth. The purpose of this investigation was to characterize the radiosensitive cell population in the deep stratum granulosum. On the basis of other studies, histochemical differences between the mature and undifferentiated elements of the stratum granulosum were postulated and demonstrated. Undifferentiated cells of the deep stratum granulosum showed diminished malic dehydrogenase and acid phosphatase activities. At the ultrastructural level these findings correlated with a paucity of small mitochondria and dense bodies rather than with the absence of these organelles. Although the cell population of the deep stratum granulosum was not uniform, the most numerous cells were tentatively identified as undifferentiated granule cells. The factors responsible for their radiosensitivity were not fully clarified. (auth)

23105 (CONF-690501--, pp 857-75) EFFECT OF IONIZING RADIATION ON THE BIOCHEMICAL DIFFERENTIATION OF THE RAT BRAIN. de Vellis, Jean; Schjeide, Ole A. (California Univ., Los Angeles).

X irradiation (100 to 1500 R) to the heads of 2-day-old rats

inhibited differentially the subsequent developmental increases of nucleic acids, individual enzymes, total protein, myelin, and total lipid in the rat brain stem and cerebral hemispheres. When irradiation was administered at later ages, a decrease in inhibition was observed with increasing age. However, the age at which radioresistance started differed widely between parameters. Glycerolphosphate dehydrogenase (GPDH) (E.C. 1.1.1.8) and isocitrate dehydrogenase (E.C. 1.1.1.42) were radiosensitive during a longer period of their development than malate dehydrogenase (E.C. 1.1.1.37), lactate dehydrogenase (E.C. 1.1.1.27), and malic enzyme (E.C. 1.1.1.40). Myelination was mostly radioresistant by the time of its onset. Observed inhibitions took place after a delay; they were dose dependent and showed no recovery to normal levels. Cortisol injections had no effect on the radiation inhibition of GPDH development (GPDH level is controlled by cortisol in the normal brain). Cortisol induction of brain GPDH in adrenalectomized rats was inhibited by irradiation. Incorporation of labeled precursors into DNA, RNA, and protein was depressed by neonatal irradiation at 2 days of age. Uridine incorporation into RNA was still affected by irradiation at 19 days of age. Inhibition of DNA synthesis in the neonatal rat brain was complete by 12 hr postirradiation. Recovery occurred several days later, and irradiated rats seemed to synthesize more DNA at that time. Irradiation at doses of 100 to 2000 R at any age caused DNA degradation. On the other hand, degradation of RNA and other compounds appeared almost negligible. Actinomycin D inhibited the developmental pattern of several parameters in a manner similar to x irradiation. It is tentatively concluded that ionizing radiation affects cell differentiation by altering the pattern of proteins synthesized at the level of transcription. Inhibition at the level of transcription is probably related to DNA damage. (auth)

23106 (CONF-690501–, pp 887-98) EFFECTS OF NEONATAL X RADIATION ON CHOLINE ACETYLTRANSFERASE ACTIVITY IN VARIOUS AREAS OF THE DEVELOPING CENTRAL NERVOUS SYSTEM. Valcana, T.; Vernadakis, A.; Timiras, P. S. (California Univ., Berkeley).

The effects of neonatal x irradiation on choline acetyltransferase (ChAc), the synthesizing enzyme of acetylcholine, were studied in discrete areas of the rat brain and at various stages of development to elucidate further the effects of x radiation on cholinergic systems. Exposure of rats to 500 R of whole-body x irradiation at 2 days after birth did not significantly alter the activity or the developmental changes of this enzyme in the cerebral cortex, hypothalamus, and spinal cord of the developing rat. In the cerebellum, however, a significant increase was observed in ChAc activity at 9 and 61 days of age, and these enzymatic changes were accompanied by equivalent but opposite changes in DNA content. It is suggested that the observed increase in ChAc activity in the cerebellum of x-irradiated rats reflects a preferential destruction of granular cells that may be noncholinergic. These cerebellar cellular abnormalities induced by x rays may contribute to the changes in general brain excitability observed after irradiation, particularly since the cerebellum is a brain area considered to be a regulator of nervous system activity. (auth)

23107 (CONF-690501–, pp 899-911) EFFECTS OF EXPOSURE TO LOW DOSES OF X RADIATION DURING PREGNANCY OF THE DEVELOPMENT OF BIOCHEMICAL SYSTEMS IN THE OFFSPRING. Nair, V. (Chicago Medical School, Ill.).

Pregnant rats received 25 or 50 R of x rays to the pelvic region on the 14th gestation day and were allowed to deliver and rear their offspring. The brain and liver of the offspring were examined at various ages until adulthood. In the brain, the development of acetylcholinesterase (AchE) and carbonic anhydrase (CA), the substrates of which are important in neural function, were studied. The development of CA was suppressed in medulla and spinal cord of male offspring. There was an initial rise in CA activity in all brain regions and the spinal cord in the females; this was statistically significant only in the spinal cord ($p < 0.01$). The activity of AchE was decreased in the caudate nucleus at all ages up to 80 days in both male and female offspring of irradiated mothers. Prenatal irradiation also impaired the development of the hepatic microsomal enzyme system metabolizing hexobarbital in the male offspring. With respect to this enzyme, the male offspring of irradiated mothers resembled the normal female rats. There are several physiologic implications of this finding because of recent evidence that the steroid hormones may be the normal substrates for this hepatic enzyme system. (auth)

23108 (CONF-690501–, pp 919-42) MECHANISMS OF RADIATION DAMAGE IN THE MAMMALIAN FETUS AND NEONATE. Schjeide, Ole A.; de Vellis, J. (California Univ., Los Angeles).

Damage by ionizing radiations in the growing and still locally differentiating mammal can be considered to be initiated by physicochemical reactions that are essentially similar to those occurring when such rays interact with most cell types. Several unique properties of dividing and differentiating cells may modify the immediate degrees of ionization, oxidation, etc., of biologically pertinent molecules and may affect the degree and nature of molecular repair. More important, metabolic conditions differing from those in fully differentiated tissues obtain, resulting in probable consequent differences in ultimate susceptibilities. In certain differentiating tissues it has been shown that moderate doses of acutely delivered ionizing radiations result in damage of the genetic material (DNA). Associated repressor molecules might also be affected. Such damages might not become apparent in mature cells, but, in cells still in the process of differentiation, the DNA's are in a key position to strongly reflect any alterations occurring in them. In the fetus and the newborn, this becomes especially important in selected tissues, such as the glial cells of the brain (myelination), the cerebellum, cerebrum, liver, and parts of the skeleton. These cells require intact DNA's to transcribe messenger RNA's for enzymes and other proteins involved in the process of further differentiation. An important feature of many such cells is that they are not killed by moderate radiation exposures, but, since their further differentiations are apparently dependent upon transcription of specific messenger RNA's at precise points in the maturation process, the failure of this transcription leaves the cell in a retarded state. (auth)

23109 DEPRESSION OF MITOSIS BY γ-GLOBULIN FROM SPLENIC X-IRRADIATED ANIMALS. Dalos, B.; Doeklen, A. Horvath, M. (Frederic Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene, Budapest). Int. J. Radiat. Biol.; 16: 501-2(1969).

Four to five mice with Ehrlich ascites tumours were given at the same time 0.4 ml 0.15 M sodium chloride or 0.5 mg γ-globulin separated from the serum of irradiated or unirradiated rabbits. In the first 12 hours afterwards the depression of the mitotic index of the tumour cells was much more frequent in mice given γ-globulin from irradiated rabbits than in the control animals. The mitotic index was also lower in the first 12 hours after injection of γ-globulin from irradiated animals than in the control mice. Between 12 and 24 hours after treatment, the mitotic index increased rapidly. (UK)

23110 NAD BIOSYNTHESIS IN RABBIT ERYTHROCYTES AND RETICULOCYTES AFTER WHOLE-BODY X-IRRADIATION. Ababei, L.; Filip, M. (Inst. of Medical Research, Iasi). Int. J. Radiat. Biol.; 16: 563-73(1969).

Endogenous NAD levels are approximately equal in erythrocytes and in reticulocytes. After whole-body irradiation with 600 R, NAD concentrations progressively decreased over the following 4 days. NAD synthesis increased after irradiation in both kinds of cells. In normal reticulocytes NAD synthesis was more accentuated than in erythrocytes. In normal erythrocytes, maximum synthesis was obtained in vitro in a system with nicotinamide, glucose, glutamine and methylene blue, and in the erythrocytes of irradiated rabbits in a system with nicotinic acid, inosine, glutamine and methylene blue. These findings suggest that, after irradiation, disorders appear in hexokinase activity and in the cellular oxide-reducing potential. Mg^{2+} ion was a powerful inhibitor of NAD synthesis in the erythrocytes of irradiated animals in the presence of inosine and of glucose. (auth) (UK)

23111 EFFECT OF D_2O ON RADIOSENSITIVITY OF CATALASE. Lohmann, Wolfgang (Gesellschaft fuer Strahlenforschung mbH, Munich). Strahlentherapie; 138: 739-41(Dec 1969). (In German).

The isotopic replacement of H_2O by D_2O renders the enzyme catalase less radiosensitive to x-rays. The mechanism of action seems to be the formation of a more stable complex between D_2O and the iron ion of the active site resulting in a modification of the electronic transitions between ligand and metal ion, which contributes to the protective effect. (auth)

23112 TAURINE METABOLISM IN MICE EXPOSED TO WHOLE-BODY X RADIATION. Streffer, Christian; Akinsanya, Ola; Schafferus, Sigrid (Univ., Freiburg i. B.). Strahlentherapie; 138: 733-8(Dec 1969). (In German).

An increased excretion of taurine is observed in female white mice, after whole-body irradiation of 690 R. This excess excretion amounts up to 90 μMol per 100 g of mouse. The amount of the amino acid also increases in liver and kidneys. After an injection of β-alanine, which by itself increases the excretion of taurine, a similar effect is observed quantitatively, as well as qualitatively. No modifications are observed in brain and heart muscle. These results and their significance for the taurine excretion are discussed. (auth)

23113 EFFECTS OF IONIZING RADIATION ON THE CONTENT OF PROTEIN, RNA, AND DNA AND ON THE NUMBER OF CELLULAR NUCLEI IN THE LIVER OF NEWBORN MICE. Heim, Fritz; Pauly, Helmut; Saebel, Manfred; Schwarzlose, Willi (Univ., Erlangen-Nuernberg, Ger.). Strahlentherapie; 138: 742-8(Dec 1969). (In German).

The liver region of 5 days old female mice was irradiated locally with a single dose of 1000 Rads of soft x-rays. The liver as well as the whole animal showed a significant decrease in growth of about 20% compared to unirradiated mice. The protein, DNA, RNA content, and the number of nuclei in the liver were determined during a period of 3½ months after irradiation. There was an early relative drop in these components within the first week, followed by a kind of recovery except for the RNA content. After a second drop recovery started again. But during the total period the liver showed a different average composition expressed by a higher content of protein, RNA, and DNA per nucleus, compared to the average cell of the liver of the unirradiated mouse. Even after a time of 3½ months mitosis was more inhibited than the synthesis of protein, RNA, and DNA. (auth)

23114 EPIDERMAL DNA SYNTHESIS IN THE FLANK OF X-IRRADIATED GUINEA PIGS. Born, Willi (Univ., Freiburg i. B.). Strahlentherapie; 138: 749-53(Dec 1969). (In German).

Epidermal DNA-synthesis of the guinea pig flank after x-ray exposure was studied. The flank epidermis of 8 guinea pigs was irradiated (1500 R; 20 kV; HVL 0.08 mm Al), and the actual DNA-synthesis was labeled with tritium thymidine at different follow-up times. After one week of depression, autoradiography showed signs of recovery during the second week, and the control values were finally exceeded. (auth)

23115 PROBES OF DNA STRUCTURE AND INTERACTIONS: EFFECTS OF COPPER(II) ON ULTRAVIOLET-INDUCED PYRIMIDINE DIMER FORMATION. Sutherland, B. M.; Sutherland, J. C. (Walter Reed Army Inst. of Research, Washington, D. C.). Biophys. J.; 9: 1329-36(Nov 1969).

The effect of uv irradiation dose rate and of Cu(II) on the production of cyclobutyl pyrimidine dimers was studied as a function of the ratio of Cu(II) to DNA phosphate, r. Cu(II) affected the yield of cyclobutyl dimers induced in DNA by 254-nm radiation. The effects were a function of r, and of the uv fluence. They seemed to reflect 2 types of copper complexes with DNA. The first probably involves exterior binding to the bases of native DNA and increases thymine–thymine (TT) formation (without affecting uracil–thymine yield) by raising the energy levels of bases other than thymine. The second seems to occur only at high ratios (rs) and only after the structure has been opened locally by uv radiation; it involves interior binding of Cu(II) to the bases. This complex tends to decrease dimer yield by holding the bases apart and/or by lowering the energy levels of bases other than thymine. These results illustrate the potential use of DNA photoproducts and ligands to probe the structure and interactions of DNA in vitro and perhaps also in vivo. (BBB)

23116 STUDIES ON THE IRRADIATION CLEAVAGE OF TRIMETHYLAMINE OXIDE IN FISH FLESH. I. DECOMPOSITION PRODUCTS FOUND IN SEVERAL FISHES. Tozawa, Harumi; Amano, Keishi (Tokai Regional Fisheries Research Lab., Kachidoki, Japan). Nippon Suisan Gakkaishi; 35: 391-6(Apr 1969). (In Japanese).

The flesh of fish rich in trimethylamine oxide (TMAO), such as cod, Alaska pollack, shark, and cuttle fish, was subjected to γ irradiation at doses from 0.6 to 5.6 Mrad, to observe to what extent TMAO, a specific constituent in marine fishes, would break down and whether it would result in undesirable quantities in the irradiated fish. Trimethylamine (TMA), dimethylamine (DMA), and formaldehyde (FA) were identified after irradiation in all the samples of the fish flesh and in TMAO solution as well. An increase in the amount of ammonia was detected in the fish samples after irradiation, but very little in the irradiated TMAO solution. Little difference in the quantity of TMA produced by irradiation was seen among the fish examined. However, a difference in the quantity of DMA was apparent, i.e., the amount of DMA formed in the flesh of gadoid fish was larger than that in shark or cuttle fish. A marked difference in DMA level was noted between two samples of Alaska pollack irradiated at the same dose. The amount of DMA in one of the irradiated Alaska pollack was much larger than that produced from pure TMAO solution under identical conditions of irradiation. The precursor of FA formed by irradiation of fish flesh may not be limited to TMAO, but a comparatively large amount of free FA recovered from the irradiated flesh of gadoid fish was presumably derived from TMAO in the tissues. (BBB)

23117 ALTERATIONS IN PROTEINS AND POLYAMINO ACIDS CAUSED BY ULTRAVIOLET IRRADIATION IN A SPECTROPOLARIMETER. Wilson, W. David; Foster, Joseph F. (Purdue Univ., Lafayette, Ind.). Biochem. Biophys. Res. Commun.; 38: 552-8(20 Feb 1970).

The Xenon lamp in a Cary 60 spectropolarimeter caused a photochemical reaction in proteins and polyamino acids which was traced to cleavage in the polypeptide chains. Viscosity studies on helical and coiled polyamino acids indicated that the cleavage occurred in both forms, but ORD changes were obtained only with helical and not with coiled and β conformations. Proteins of high helix content exhibited a significant change in ORD that was enhanced in the presence of denaturants. Quantum yields based on ORD change were greater in the $n \rightarrow \Pi^*$ than in the $\Pi \rightarrow \Pi^*$ transition region. (auth)

23118 ON THE PHOTOLYSIS OF C-S-BONDS IN PROTEINS. Mueller, H. -G. (Deutsche Akademie der Wissenchaften, Berlin). Biophysik, 6: 190-2(1969). (In German).

By means of sulfate determination in uv-irradiated ribonuclease and subsequently oxidized with performic acid the cleavage of C—S bonds was proven. This reaction is of high importance for the enzyme. (auth)

23119 PHOTOHYDRATION OF URIDINE IN THE RNA OF COLIPHAGE R17. II. THE RELATIONSHIP BETWEEN ULTRAVIOLET INACTIVATION AND URIDINE PHOTOHYDRATION. Remsen, J. F.; Miller, N.; Cerutti, P. A. (Princeton Univ., N. J.). Contract AT(30-1)-4114. Proc. Nat. Acad. Sci. U. S.; 65: 460-6(Feb 1970).

Uridine photohydrates (6-hydroxy-5,6-dihydrouridine) are the major products formed upon irradiation of the RNA bacteriophage R17 with ultraviolet light at 280 mμ, while cyclobutane-type pyrimidine dimerization does not occur to an appreciable extent. The suppression of dimerization may indicate that the RNA inside the phage is held in a rigid conformation in close contact with the phage protein. A value of 0.94 (±0.10) uridine photohydrates per biological hit is obtained from a correlation of the fraction of phage surviving with the number of photohydrates formed as a function of ultraviolet dose. It is concluded that uridine photohydrates represent a major part of the lethal damage caused by ultraviolet light in bacteriophage R17. An efficient system for dark repair of uridine photohydration seems to be lacking in E. coli. (auth)

23120 REPAIR OF X-RAY DAMAGE TO THE DNA IN MICROCOCCUS RADIODURANS: THE EFFECT OF 5-BROMODEOXYURIDINE. Lett, J. T. (Colorado State Univ., Fort Collins); Caldwell, I.; Little, J. G. J. Mol. Biol.; 48: 395-408 (28 Mar 1970).

Radiation damage to the DNA of Micrococcus radiodurans is eliminated or modified by processes which effect the rejoining of DNA strand breaks and degradation of the DNA. The enzyme system that is responsible for DNA degradation also appears to be implicated in the removal (excision) of damaged DNA constituents. Following anoxic x irradiation the survival of the bacterium exceeds 95% at doses below 500 krads. Progressive replacement of the thymine in the cellular DNA by 5-bromouracil results in the progressive removal of the shoulder from the anoxic x-ray survival curve with little change in the slope. There does not appear to be a concomitant effect upon either the extent of DNA strand breakage or the properties of the system rejoining the breaks. However, the loss of the shoulder from the survival curve is paralleled by interference with DNA degradation. When the level of the 5-bromouracil incorporation is such that the shoulder has been eliminated from the survival curve, the degradation–excision system is inoperative. (auth)

23121 DNA DAMAGE AND REPAIR IN LIGHT-SENSITIVE HUMAN SKIN DISEASE. Cleaver, J. E. (Univ. of California, San Francisco). J. Invest. Dermatol.; 54: 181-95(Mar 1970).

Cultures of fibroblasts were developed from skin biopsies of xeroderma pigmentosum patients. Cells were uv-irradiated and allowed to develop into visible colonies in 14 to 21 days. The medium was replaced with freshly prepared medium containing ^{3}HTdR or ^{3}HBrUdR. Following incubation the cells were processed for cesium chloride density gradient analysis or autoradiography. A discussion is presented of results for the following aspects of the experiment: sensitivity of normal skin fibroblasts to killing by uv light; normal DNA replication; DNA repair demonstrated autoradiographically; DNA repair demonstrated by density gradient methods; repair synthesis after exposure to sunlight; repair synthesis in various skin diseases; and repair of pyrimidine dimers in uv-irradiated cells. Results indicate that absence of DNA repair in xeroderma pigmentosum is correlated with a defective enzyme, and a question raised by identification of the enzyme defect in xeroderma pigmentosum is the connection between unrepaired DNA damage and carcinogenesis. (H.L.W.)

23122 INVESTIGATION OF THE NATURAL COMPLEX DNA–RNA IN THE LIVER OF IRRADIATED RATS. Paskevich, I. F.; Shantyr, V. I.; Todorov, I. N. Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 10, 923-6(Oct 1969). (In Ukrainian).

Studies of the DNA–RNA complex isolated from the liver of the irradiated rats two hours after exposure to 800 R doses showed that the main part of the radioactive material connected with DNA belongs to RNA being in a complex with DNA. By means of chromatography of the DNA–RNA complex preparation, twice treated by RNA, on columns from the methylated albumin on kieselguhr, it was established that irradiation causes the essential increase of the zones of radioactivity connected with DNA. This increase of RNA radioactivity probably is conditioned first of all by the activation as a result of irradiation of the new genes previously repressed in a norm. (auth)

23123 A STUDY OF POSTRADIATION DAMAGE IN SUBMOLECULAR STRUCTURE OF DNA UNDER DIFFERENT RADIATION CONDITIONS. Pinto, R. I.; Barenfel'd, L. S.; Gunchev, Kh. Z. (Inst. of Cytology, Leningrad). Tsitologiya; 12: 343-51(Mar 1970). (In Russian).

Changes in the viscosity and intensity of a secondary fluorescence of preparations of DNA submolecular structures isolated from the rat thymus after irradiation in vivo were investigated using different doses and radiation regimes. The intensity of the secondary fluorescence was measured throughout a gradual increase of the preparation temperature from 20 to 60°C. The results suggest that damages to DNA observed during irradiation are caused by destruction of submolecular structures and local damages in the system of hydrogen bonds. The tested properties of DNA depended essentially on the events occurring in the cells immediately after irradiation. Therefore, a secondary irradiation with 5 to 15 minute intervals altered the pattern of radiation damage, whereas an irradiation with 30 minute intervals resulted in the accumulation of damage. (auth)

23124 QUANTITATIVE DESCRIPTION OF POST-RADIATION CHANGES OF SIALIC ACIDS IN WHITE RAT TISSUES. Malashevich, E. V. (Inst. of Physiology, Minsk). Dokl. Akad. Nauk BSSR; 14: 72-3(Jan 1970). (In Russian).

Graphic data were constructed on the dynamics of the changes in sialic acids in tissues (brain, liver, cardiac muscle, and blood serum) in white male rats weighing 180 to 220 g and exposed to neutron doses of 13.5 rad. The curves exhibited the changes taking place 1, 3, and 6 hr and 1, 3, 7, 15, and 30 days following exposure. (R.V.J.)

23125 ACTIVITY OF ALKALINE PHOSPHATASE OF NEUTROPHILS IN TELEGAMMATHERAPY OF CANCER OF THE UTERINE CERVIX. Goryacheva, L. L.; Shubich, M. G.; Isaenko, E. I. (Kuban Medical Inst., USSR). Med. Radiol.; 15: No. 3, 15-19(Mar 1970). (In Russian).

Alterations in the activity of alkaline phosphatase of neutrophilic leukocytes of the peripheral blood in 173 patients with cancer of the uterine cervix of the I, II, and III stages who were subjected to telegammatherapy are reported. The phosphatase activity of neutrophils was determined with the aid of the asocombination reaction in M. G. Shubich's modification. The phosphatase activity in these patients was augmented and the degree of its rise was associated with the spread of the process. Under the influence of telegammatherapy the enzymatic activity rose significantly. (auth)

Immunology

Refer also to abstract 23235.

23126 IMMUNOSUPPRESSION BY MEANS OF IRRADIATION. Thiel, G. Arch. Klin. Chir.; 322: 475-84(1968). (In German).

Methods of immunosuppressive irradiation suitable for organ transplantation procedures were discussed. When whole-body ^{60}Co irradiation was used for kidney transplantation, a dose of 400 to 460 R, calculated at the middle sagittal plane of the body, was given in 1 or 2 doses. Transplantation was performed on the day after the last irradiation, and was followed by a leukopenia. The main advantage of whole-body irradiation was that the patient did not require drugs for immunosuppression for as long as 7 yr afterward. The disadvantages were the mortality from infection during the leukopenic stage and variations in individual radiosensitivity. Whole-body irradiation was suitable for experimental bone marrow transplantation. Localized x irradiation of the transplanted spleen has been abandoned, but fractionated doses of 150 R each up to a maximum total of 1200 R have been used for kidney transplants. Possible mechanisms of a localized irradiation effect include decreased antigenicity of the transplant, alteration of the transplant bed, injury of the afferent or efferent components of the immunogenic defense response, or some specific inflammatory effect. The rationale for extracorporal irradiation of blood to produce immunosuppressive effects was discussed, but this method was not considered to be feasible. It was concluded that the most practical irradiation method for immunosuppression was localized irradiation of the transplanted organ. (BBB)

23127 INFLUENCE OF THYMOSIN ON CELL-MEDIATED AND HUMORAL IMMUNE RESPONSES IN NORMAL AND IN IMMUNOLOGICALLY DEFICIENT MICE. Goldstein, Allan L.; Asanuma, Yoshitsugu; Battisto, Jack R.; Hardy, Mark A.; Quint, Jerome; White, Abraham (Yeshiva Univ., Bronx, N. Y.). J. Immunol.; 104: 359-66(Feb 1970).

Thymosin, a cell-free, lymphocytopoietic factor prepared from calf thymus, was examined for its influence on cell-mediated and humoral immune responses in normal and immunologically deficient mice. Thymosin was administered to the following groups of mice: normal adult; neonatally thymectomized; adult, lethally irradiated; and adult, thymectomized, lethally irradiated animals given syngeneic bone marrow cells. Immune responses of the mice in each group were assessed on the basis of their response to a skin allograft and their capacity to form humoral antibody. Thymosin restored the skin allograft response in neonatally thymectomized mice, thus supporting our conclusion that this thymic function may be endocrine in nature. The capacity to form 19S antibody in neonatally thymectomized or adult thymectomized, lethally irradiated mice was not markedly altered by thymosin treatment, suggesting the lack of a primary function for thymosin in these experimental conditions. Thymosin had no stimulatory effect on the hemolysin response to sheep erythrocytes in normal and x-irradiated mice when given after the initial antigenic challenge. When thymosin was administered prior to antigenic challenge, there was a reduction in hemolysin titers. A hypothesis is presented suggesting that control by the thymus of cell-mediated immunity resides primarily in an endocrine function of the gland, with maturation of peripheral stem cells occurring under the influence of thymosin. In contrast, maturation of cells involved in humoral immune responses may require an in situ thymic locus under the influence of one or more humoral factors and/or interaction with other stem cells, and may be initiated and essentially completed prior to birth. (auth)

Ecology

Refer also to abstracts 23181, 23182, 23184, 23189, 23193–23195, and 23232–23234.

23128 (AEC-tr-7126) PROBLEMS OF DISTRIBUTION AND EXPERIMENTAL EVALUATION OF PERMISSIBLE LEVELS OF ^{137}Cs, ^{90}Sr, AND ^{106}Ru. Buldakov, L. A.; Moskalev, Yu. I. Translation of Problemy Raspredeleniya i Eksperimental'noi Otsenki Dopustimykh ^{137}Cs, ^{90}Sr, i ^{106}Ru, Atomizdat, Moscow, 1968. 281p. Dep. CFSTI.

Distribution, metabolism, and migration along biological chains of ^{137}Cs, ^{90}Sr, and ^{106}Ru are reviewed. The pattern of distribution of the radioisotopes in single, as well as protracted entry in the organism of various animals, including farm stock, is analyzed. Much attention is given to the kinetics of ^{137}Cs and ^{90}Sr metabolism in the human organism. Secretion of these radioisotopes with the milk, and their transmission to the progeny is analyzed. The ways and means of normalizing the permissible levels of radioisotopes in air, water, and foodstuffs are given. (auth)

23129 (AED-C-2-9) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 2. CONTAMINATION AND DECONTAMINATION OF FOOD. Beising, K. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct 1969. 69p. Dep. CFSTI (U. S. Sales Only). ZAED.

Approximately 6,000 references are presented to recent worldwide publications on the contamination of food by fallout radionuclides and methods for removal of radioactivity from foods. (C.H.)

23130 (BMI-171-126) BIOENVIRONMENTAL SAFETY STUDIES, AMCHITKA ISLAND, ALASKA. MILROW D +2 MONTHS REPORT. Amchitka Bioenvironmental Program. Kirkwood, James B. (Battelle Memorial Inst., Columbus, Ohio). 20 Mar 1970. Contract AT(26-1)-171. 41p. Dep. CFSTI.

The immediate ecological effects of Milrow, an underground nuclear test of about 1-megaton yield conducted on October 2, 1969, at Amchitka Island, Alaska, were minimal according to a partial analysis of data collected and observations recorded during September, October, and November, 1969. Studies during

this period were concerned with recording preevent and post-event ecological conditions and conducting live-box, holding-pen, and other experiments at testtime. Preliminary results of these studies showed the following: a few fish were killed or injured in the inshore marine environment; numerous threespine sticklebacks were killed in two lakes near Milrow surface ground zero (SGZ), but Dolly Varden char in the same lakes apparently were not harmed; rock and soil slides occurred on coastal areas near SGZ; zooplankton abundance decreased in one lake 2.2 miles from SGZ, but not in lakes closer to SGZ; several sea stacks and sea cliffs utilized during the spring and early summer as nesting sites by eagles and other birds were damaged; water levels of some lakes and water flows in some streams were changed; and the Amchitka sea otter population was not adversely affected. The complete analyses of the testtime studies, including analysis of aerial photographs, will be included in future reports that are being prepared by scientists from Battelle's Columbus Laboratories, The Ohio State University, Utah State University, University of Tennessee, University of Washington, Smithsonian Institution, Cornell University, and the United States Department of the Interior. The long-term ecological effects of Milrow are the subject of continuing studies. Results will be reported when they are obtained. (auth)

23131 (BMI-171-201) POST-EVENT BIOENVIRONMENTAL SAFETY ASPECTS, PROJECT RULISON. Fuller, R. G.; Davidson, R. S. (Battelle Memorial Inst., Columbus, Ohio). 6 Jan 1970. Contract AT(26-1)-171. 7p. (PNE-R-25). Dep. CFSTI.

The effects of the Rulison detonation on the surrounding ecosystem were minimal, and no significant adverse effects were noted during the post-event observations. There was a temporary increase in turbidity and water color in Battlement Creek water immediately after the detonation, although this was at least partly caused by a local rain and hailstorm. In any case, the increase in turbidity was transient and caused no significant problems for water users. Pre-event measures taken to prevent entry of oil and other drilling wastes into the watershed were apparently effective. (auth)

23132 (CLOR-77) RADIOSTRONTIUM IN TOTAL DIET OF SOME POPULATION GROUPS IN POLAND IN 1965-1966. Czosnowska, W.; Pietrzak-Flis, Z.; Grabowski, D. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1969. 11p. Dep. CFSTI (U. S. Sales Only).

The level of ^{90}Sr and Ca in diet of teenagers living at Sochaczow and children living in Warsaw was investigated. In the period 1965 and 1966 no significant difference was observed between the levels of $^{90}Sr/Ca$ in the diets taken from both localities, but a significant difference was observed between the levels of this ratio in milk sampled from these localities. The results of this work confirmed the fact of the specific composition of the diet and low Ca intake in Poland, observed in the investigation of the $^{90}Sr/Ca$ ratio in the diet in Poland in 1960 to 1963. It was pointed out that the $^{90}Sr/Ca$ ratio in representative milk samples cannot be an accurate indicator of the $^{90}Sr/Ca$ ratios in total diet of the population in Poland. (auth)

23133 (MLM-1616) ENVIRONMENTAL MONITORING REPORT: JULY-DECEMBER 1969 AND 1969 SUMMARY. Anderson, H. F.; Sheehan, W. E. (Mound Lab., Miamisburg, Ohio). 2 Mar 1970. Contract AT(33-1)-Gen-53. 50p. Dep. CFSTI.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, is presented for the second half of 1969, and a summary is presented for the entire year. The average concentration of radionuclides from Mound Laboratory in the Great Miami River and in the environmental air was within the stringent standards of safety specified by the Atomic Energy Commission. (auth)

23134 (NP-18122) ENVIRONMENTAL RADIOACTIVITY AND RADIATION BURDEN. Annual Report, 1968. (Bundesminister fuer Wissenschaftliche Forschung, Bonn (West Germany)). 1 Sep 1969. 153p. (In German). Dep. CFSTI (U. S. Sales Only).

Environmental radioactivity and radiation burdens to the population are reported. Three separate abstracts were prepared. (H.B.G.)

For abstracts of individual sections see: 23135, 23136, and 23183.

23135 (NP-18122, pp 6-104) GENERAL ENVIRONMENTAL RADIOACTIVITY. (Bundesminister fuer Wissenschaftliche Forschung, Bonn (West Germany)). (In German).

Radioactivity found in air, rain deposits, surface water, brackish water, seawater, sewer systems, soil and plants, drinking water, milk and milk products, grain, meat, fish, and other food stuffs is summarized in more than 200 tables and graphs. Also tabulated are the results of whole-body counting in man with respect to ^{137}Cs and ^{90}Sr. In general, radioactivity in Germany shows a steady decline since 1964, which is more pronounced for ^{90}Sr than for ^{137}Cs. The correlation between environmental radioactivity and nuclear test explosions is discussed. (H.B.G.)

23136 (NP-18122, pp 127-53) RADIATION BURDEN TO THE POPULATION. (Bundesminister fuer Wissenschaftliche Forschung, Bonn (West Germany)). (In German).

Different factors of radiation burdens to the population of Germany caused by nuclear explosions were discussed. Hazards resulting from increased environmental radioactivity and from long lasting fallout were determined by analyzing ^{137}Cs and ^{90}Sr content in various food stuffs. These radioisotopes were also measured in the human body. External γ radiation burden due to fallout was assessed and evaluated. (H.B.G.)

23137 (NRL-F-36) ENVIRONMENTAL RADIOACTIVITY IN NEW ZEALAND AND MEASUREMENTS ON SAMPLES FROM FIJI AND RAROTONGA. Quarterly Report, July-September 1969. (National Radiation Lab., Christchurch (New Zealand)). 11p. Dep. CFSTI.

Results of routine monitoring of fallout in samples of atmosphere, rain, and milk collected in New Zealand during the third quarter of 1969 are reported. Data are included on: the content of ^{90}Sr in samples of milk and rain water; the content of ^{89}Sr in rain; and the content of ^{137}Cs in milk. (C.H.)

23138 (ORNL-IBP-70-2) PITFALL I: A GENERAL PURPOSE DATA PROCESSING PROGRAM FOR ENVIRONMENTAL DATA. Hull, Norma C.; Beauchamp, John J.; Reichle, David E. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 67p. Dep. CFSTI.

PITFALL I is designed to enable the individual researcher to participate in the processing and analysis of complicated data sets requiring storage, recall, summarization, and basic statistical analysis. Although originally developed for handling extensive environmental data, the programs' flexibilities lend them applicable to situations where recovery and recombination of data in three-dimensional arrays (e.g., attribution evaluation for species in time and space) are needed. The problem for which PITFALL I originally was developed is described. In addition, sections on statistics and data processing are included. (auth)

23139 (ORO-2412-24) EFFECTS OF RADIATION ON PLANT AND ANIMAL COMMUNITIES. Progress Report, January 1969-January 1970. Platt, Robert B. (Emory Univ., Atlanta, Ga. Dept. of Biology). Feb 1970. Contract AT(40-1)-2414. 58p. Dep. CFSTI.

Research on the ecology of Panola Mountain included selection of specific research sites and placement and activation of environmental stations. Methods of obtaining data on rainfall, temperature, soil temperature and moisture, day length, and solar radiation are described. An experiment on ^{32}P tagging of a Diamorpha community was designed to determine the quantity of radioactivity required for later experiments, to test one method of radionuclide application, and to test for mechanisms of ^{32}P movement from the community. A tentative food chain for Diamorpha communities was formulated. Modeling and computer programs were developed for handling data reduction programs associated with Panola. The digital computer was used for adapting the condensing several programs for radioactive decay correction and transformation of count data to activity units. Leaching experiments were performed using seedlings of Viguiera porteri. Four plants were inoculated with ^{134}Cs and four days later two plants were exposed to 5.6 kR γ radiation. Results suggested that sublethal doses of radiation increased the leaching rate of ^{134}Cs. Progress is reported on the following subprojects: fungal ecology of granite outcrops of the southeastern Piedmont; secondary succession in a field receiving active transport from a large granite outcrop; ecological effects from close-in fallout from cratering events at the Nevada Test Site; cooperative studies with Georgia Power Company on the environmental effects of their nuclear power reactor at Baxley; and effects of microweathering and microtopography of granite on the distribution of saxicolous plants. (H.L.W.)

23140 (SWRHL-37-r) OFF-SITE SURVEILLANCE ACTIVITIES OF THE SOUTHWESTERN RADIOLOGICAL HEALTH LABORATORY FROM JANUARY THROUGH JUNE 1966. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Jan 1970. 93p. Dep. CFSTI.

Off-site radiological surveillance was performed for twenty-nine announced events and nine reactor experiments at the Nevada Test Site during the period from January through June 1966. During the six month period, three announced nuclear events and six reactor experiments released radioactivity which was detected off-site. Analysis of all sampling and surveillance performed during the six month period indicates that the safety criteria es-

tablished by the Atomic Energy Commission for the off-site population were not exceeded. (C.H.)

23141 (SWRHL-82) PROCEEDINGS FOR THE SYMPOSIUM ON PUBLIC HEALTH ASPECTS OF PEACEFUL USES OF NUCLEAR EXPLOSIVES, LAS VEGAS, NEVADA, APRIL 7-11, 1969. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). 759p. (PB-187349; CONF-690406). Dep. CFSTI.

Separate abstracts were prepared for 28 of the 40 papers presented at the symposium. Eleven of the papers appeared previously in NSA. The last paper in the proceedings contains a summary of the highlights of the symposium and some closing remarks. (E.R.B.)

For abstracts of individual papers see: 22772, 22790, 22836-22844, 23142-23150, 23196, 23224, and 23229-23234.

23142 (SWRHL-82, pp 1-8) PUBLIC HEALTH AND PLOWSHARE. Terrill, James G. Jr. (Public Health Service, Washington, D. C.).

Because public health must be a primary concern in the Plowshare Program, it is essential that the potential risks be weighed against the expected benefits to the public. Public health agencies must play an increasingly important role in the planning and operational stages of the peaceful applications of nuclear explosives and in the final stage of consumer use of Plowshare-generated products. There are many long term and long distance ramifications of the Plowshare Program, such as the potential radiological contamination of consumer products that may reach the consumer at long times after the event or at great distances from the site of the event. Criteria for evaluating public exposure to radiation from these products need to be developed based on sound scientific research. Standards for radioactivity in consumer products must be developed in relation to potential exposure of the public. Above all, a clear benefit to the public with a minimum of risk must be shown. A general overview of a symposium on the public health aspects of peaceful uses of nuclear explosives is presented. (auth)

23143 (SWRHL-82, pp 176-84) SAFETY PHILOSOPHY IN PLOWSHARE. Thalgott, Robert H. (Nevada Operations Office (AEC), Las Vegas).

A nuclear device can be detonated safely when it can be ascertained that the detonation can be accomplished without injury to people, either directly or indirectly, and without unacceptable damage to the ecological system and natural or man-made structures. This philosophy has its origin in the nuclear weapons testing program dating back to the first detonation in 1945 and applies without reservation to Plowshare projects. The mechanics employed by government in implementing this safety philosophy are outlined and the types of actions taken by safety oriented organizations and committees to assure that necessary and desirable safety reviews are conducted are described. (auth)

23144 (SWRHL-82, pp 401-35) ECOLOGICAL TRANSFER MECHANISMS - TERRESTRIAL. Martin, William E.; Raines, Gilbert E.; Bloom, Sanford G.; Levin, Arthur A. (Battelle Memorial Inst., Columbus, Ohio).

Radionuclides produced by nuclear excavation detonations and released to the environment may enter a variety of biogeochemical cycles and follow essentially the same transfer pathways as their stable-element counterparts. Estimation of potential internal radiation doses to individuals and/or populations living in or near fallout-contaminated areas requires analysis of the food-chain and other ecological pathways by which radionuclides released to the environment may be returned to man. A generalized materials transfer diagram, applicable to the forest, agricultural, and freshwater and marine ecosystems providing food and water to the indigenous populations of Panama and Colombia in regions that could be affected by nuclear excavation of a sea-level canal between the Atlantic and Pacific Oceans, is presented. Transfer mechanisms effecting the movement of stable elements and radionuclides in terrestrial ecosystems are discussed, and methods used to simulate these processes by means of mathematical models are described to show how intake values are calculated for different radionuclides in the major ecological pathways leading to man. These data provide a basis for estimating potential internal radiation doses for comparison with the radiation-protection criteria established by recognized authorities; and this, in turn, provides a basis for recommending measures to ensure the radiological safety of the nuclear operation plan. (auth)

23145 (SWRHL-82, pp 478-86) PUBLIC HEALTH SERVICE SAFETY PROGRAM. McBride, John R. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.).

Off-Site Radiological Safety Programs conducted on past Plowshare experimental projects by the Southwestern Radiological Health Laboratory for the AEC are presented. Emphasis is placed on the evaluation of the potential radiation hazard to off-site residents, the development of an appropriate safety plan, pre- and post-shot surveillance activities, and the necessity for a comprehensive and continuing community relations program. In consideration of the possible wide use of nuclear explosives in industrial applications, a new approach to off-site radiological safety is discussed. (auth)

23146 (SWRHL-82, pp 487-97) STATE AND LOCAL SAFETY PROGRAM. Thompson, G. D. Carlyle (Utah State Div. of Health, Salt Lake City).

The need to increase the state's participation, along with the Federal agencies, in the development of state and local confidence with respect to the safety of their residence in relation to the Plowshare Program is emphasized. The principle of control at the source is also stressed. Other factors relating to the Program that are discussed include monitoring; standards and their use; control actions; public relations; advanced feasibility studies; government responsibilities to their citizens; analysis of the ecological systems; and research on the short- and long-term effects of radioactivity on man. (E.R.B.)

23147 (SWRHL-82, pp 585-94) EXPOSURE-DOSE RESEARCH FOR RADIONUCLIDES IN NATURAL GAS. McNelis, D. N.; Patzer, R. G. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.).

The fate determination of specific radionuclides in natural gas stimulated by underground engineering applications is being examined. An experimental program, now in its initial stages, is using gas artificially labeled with ^{85}Kr and tritium under simulated domestic situations. The following topics are being investigated in this study: the concentration of the radionuclides in a gas-heated home; the build-up of contamination on appliances in the kitchen environment; the concentration in foods as a function of radionuclide, food type, and preparation; and the maximum exposure plausible under specified conditions. (auth)

23148 (SWRHL-82, pp 652-63) RADIOLOGICAL SAFETY RESEARCH FOR NUCLEAR EXCAVATION PROJECTS. Klement, A. W. Jr. (Nevada Operations Office (AEC), Las Vegas).

The general radiological problems encountered in nuclear cratering and nuclear excavation projects are discussed. Procedures for assessing radiological problems in such projects are outlined. Included in the discussions are source term, meteorology, fallout prediction, and ecological factors. Continuing research requirements as well as pre- and post-excavation studies are important considerations. The procedures followed in the current interoceanic canal feasibility studies provide examples of radiological safety problems, current solutions, and needed research. (auth)

23149 (SWRHL-82, pp 697-712) ROLE OF INDUSTRY IN THE ENVIRONMENTAL HEALTH AND SAFETY ASPECTS OF THE DEVELOPING PLOWSHARE INDUSTRY. Hilberry, Norman (Arizona Univ., Tucson).

It is pointed out that no person or organization has a more vital interest in the early establishment of an effective health and safety program within which commercial operations based on Plowshare technology can be carried on with assurance than does that facet of industry that is directly involved in the attempt to prove out these Plowshare applications. The formulation of such a code must be a matter of the highest priority to all concerned. To accomplish this task successfully, however, requires the exercise of objectivity both on the part of the Government agencies who bear statutory responsibility for ensuring the public health and safety and also on that of the industrial groups involved. The basic nature of the joint operating procedure required to provide an effective way of fulfilling these common obligations is examined. The present stage of the developmental progress of the potential Plowshare industry is discussed in terms of the technological feasibility, the economic feasibility, and the attainment of public acceptance. Whether or not any proposed commercial application will prove to be economically feasible and whether or not public acceptance can be achieved will depend on the nature of the essential health and safety activities required and on the associated costs of these activities. (E.R.B.)

23150 (SWRHL-82, pp 736-51) STATE PARTNERSHIP IN ENVIRONMENTAL HEALTH AND SAFETY PHASE OF PLOWSHARE PROJECTS. Kinsman, Simon (California Dept. of Public Health, Berkeley).

When experiments on projects involving Plowshare devices are conceived, the state chosen for the project should be invited to participate in planning the health and safety aspects and be prepared to actively participate in the D-Day phase as well as the

post-detonation activity. In California, nuclear science technology and competence have preceded the social acceptance and use of nuclear devices for large scale Plowshare projects. However, the environmental surveillance program of the Bureau of Radiological Health in the State Department of Public Health has established an operative program to function as an active participant or in a support role in environmental health phases of nuclear projects scheduled in the State. A description of the present program is given. (auth)

23151 (TID-25339) AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT. Progress Report. Bader, R. G. (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Jan 1970. 81p. Dep. CFSTI.

During 1969 data on temperature, salinity, oxygen, copper, iron, and nutrients were obtained routinely in Biscayne Bay adjacent to Turkey Point. The objective was to determine the effects of heated effluent from an existing fossil fuel electric generating plant on the ecology of the southern part of the Bay and to attempt to predict the impact of additional effluent from proposed nuclear fuel plants. Studies on the diversity and population structure of micro and macro algae, sea grasses, fungi, and animals were conducted. Experimental laboratory studies on algal and animal temperature tolerances were conducted. (C.H.)

23152 (TID-25342) COLORADO TROUT LAKE STUDIES. Progress Report, 1969. (Colorado Dept. of Natural Resources, Fort Collins. Div. of Game, Fish and Parks). 20 Jan 1970. 12p. Dep. CFSTI.

Limnological measurements were made on water temperature, depth of secchi disk visibility, and dissolved oxygen concentrations. All fish caught were identified, sexed, weighed, and measured, and representative samples were taken for analysis of ^{137}Cs concentrations in muscle tissue. Results of studies on three lakes are tabulated. Mean concentrations of ^{137}Cs remained relatively high in rainbow trout caught from East Twin Lake, large brown trout from Lower Agnes Lake, and cutthroat trout from Upper Snow Lake. From these results it is concluded that in the event of renewed contamination of the environment by radioactive fallout, the larger fish from similar montane and alpine lakes would present the greatest potential health hazard if caught and consumed by fishermen. (H.L.W.)

23153 RADIONUCLIDES OF INTEREST IN THE SPECIFIC ACTIVITY APPROACH. Lowman, Frank G. (Puerto Rico Nuclear Center, Mayaguez). Bioscience; 19: 993-1002(Nov 1969).

Radiation safety is considered relative to the use of nuclear explosives for the construction of an isthmian sea-level canal. Radionuclides from fusion, fission, and neutron activation of the structural components of the device and the surrounding material will be mixed, with stable vaporized metal, water, and rock. Various approaches to evaluating the hazards of contamination of the biosphere are reviewed. How the sp. act. method may be applied to feasibility studies for a sea-level isthmian canal in eastern Panama or northwestern Colombia is described. If the sp. act. in food organisms are calculated as shown, and the amount of stable element per unit liveweight of organism is derived from analyses of organisms collected in the area of interest, the amounts of the radionuclide per unit liveweight may be calculated. Thus the results of the analyses and calculations may be applied in cases where the concentrations of radionuclides were calculated on a maximum permissible concentration basis for foods from a wide variety of sources or in cases where the limitations on food utilization are based on the maximum permissible sp. act. allowed in the critical organs of man. (auth)

23154 THERMAL DEATH MODELS. Jaske, R. T.; Templeton, W. L.; Coutant, C. C. (Battelle Memorial Inst., Richland, Wash.). Ind. Water Eng.; 6: 24-7(Oct 1969).

Several techniques being used to evaluate the interaction of thermal discharges from the Hanford nuclear station with the highly regulated regime of the Columbia River below Priest Rapids Dam are described. The peaking practices followed by the Northwest Power Pool cause routine variations in river flow ranging from 35,000 to 16,000 cfs. Death models were developed that predict the mortality and equilibrium loss of young salmon under conditions of fluctuating but lethal temperatures. Longitudinal spreading of the thermal discharge increases as the flow rate increases. But, contrary to previous theoretical predictions, the prompt spreading in the lateral direction appears to decrease at higher flow rates. If the product of the lateral and longitudinal dimensions of a spreading dye patch are used as the parameters to relate the total surface area, the resulting area grows less as a function of time at the higher flow rates than at the lower flow rates. This implies that there may be an optimum flow rate-unit area growth ratio for various configurations. The model described considers the rate of temperature change of thermally sensitive fish tissue relative to the external water temperature, both during exposure to a fluctuating thermal regime and in establishing input resistance data. Loss of equilibrium of fish is taken as the effective death point. It is suggested that such models will permit the delineation of boundary conditions for plant design, not only as regards thermal releases but also chemical toxicants. (BBB)

23155 UPTAKE OF ^{131}I BY THE BIOTA OF FERN LAKE WASHINGTON, IN A LABORATORY AND A FIELD EXPERIMENT. Short, Zella F.; Palumbo, R. F.; Olson, P. R.; Donaldson, J. R. (Univ. of Washington, Seattle). Ecology; 50: 979-89(Autumn 1969).

The distribution of ^{131}I among the biota of Fern Lake, Washington, was compared in aquarium and field experiments. The samples for study in the laboratory were isolated in containers so that the water solution, and not food, was the major source of the radionuclide. The field experiment related the uptake of ^{131}I by organisms isolated in containers to the accumulation by those with access to their usual sources of food. The organisms included Nitella flexis, crayfish, mussels, trout, and an amphipod. In the aquarium, the initial concentration of ^{131}I was 8,000 times the average concentration calculated for the lake experiment. Maximum concentration factors ranged from 1.7 and 2.6 for the muscle of trout and crayfish, respectively, to 280 for the thyroid of trout, 380 for Nitella flexilis and 600 for an amphipod, Gammarus sp. Iodine-131 was not detected in a number of samples collected from the lake, but accumulation factors were as high as 1,400 for Nitella clumps and 12,000 for the thyroid of trout. Young microcrustaceans, which are able to accumulate iodine directly from water, were an important source of ^{131}I for trout. (auth)

23156 PECULIARITIES OF UPTAKE OF GLOBAL ^{137}Cs AND ^{90}Sr FROM DIFFERENT FOOD SOURCES BY THE POPULATION OF POLES'YA. Marei, A. N.; Barkhudarov, R. M.; Chumak, V. K.; Petukhova, E. V.; Tyuryukanova, E. B.; Kuznetsova, G. A.; Novikova, N. Ya.; Pozhivilova, S. B.; Bogdanovich, G. A. Gig. Sanit.; No. 1, 61-6(Jan 1970). (In Russian).

Data are presented on the order of passage of ^{137}Cs and ^{90}Sr from the soil into food products with due regard for the soil nature and the accumulation of isotopes in the human body. The extent of the passage of ^{137}Cs from the soil into food products fluctuated considerably and depended on the type of soil. Thus, in a soil consisting mainly of a sand fraction, the passage of ^{137}Cs was more pronounced. Similar observations were made in respect to all of the objects examined. However, no differences could be detected in the migration of ^{90}Sr. Because of the high passage of ^{137}Cs into food products, its content in the human body was high as well. (auth)

Genetics and Cytogenetics

Refer also to abstracts 23326, 23388, 23395, and 23396.

23157 (NYO-1800-31) INBORN ANEMIAS IN MICE. Progress Report, February 1, 1969-January 31, 1970. Russell, Elizabeth S.; Bernstein, Seldon E. (Jackson Lab., Bar Harbor, Maine). 9 Feb 1970. Contract AT(30-1)-1800. 18p. Dep. CFSTI.

Studies were conducted on hereditary disorders of rodent erythrocytes in microcytic and normal mice were conducted using the technique for monitoring endogenous production of ^{14}C-labeled carbon monoxide in expired air following injection of glycine-2-^{14}C. Experiments on steel gene action in anemic mice included ^{59}Fe uptake studies and x irradiation of steel anemic recipients 4 hrs prior to receipt of spleen transplants. Experiments on radiosensitivity of anemic mice showed that steel anemic mice that had received functional nonerythroid components from normal spleen grafts did not have an elevated resistance to total-body x irradiation. Studies on serial transplantation of spleens between different genotypes indicated that stem cells possess generative and regenerative properties and that when deficient in an animal they confer upon it both an anemic status and a marked sensitivity to x radiation. Results of studies on plasma erythropoietin levels in normal and anemic mice subjected to hemopoietic stress showed that 200 R whole-body x irradiation did not impair capacity to produce erythropoietin. Further progress is reported on enzyme studies of flexed mice with transitory siderocytic anemia; developmental and physiological studies of Hertwig's anemia; preliminary characterization of a new lethal macrocytic anemia; and importation into The Jackson Laboratory of three new mouse hereditary anemias. (H.L.W.)

23158 INHERITANCE OF RADIATION-INDUCED SPINAL CURVATURES IN THE GUPPY LEBISTES RETICULATUS. Schroeder, J. H. (Society for Radiation Research, Neuherberg, Ger.). Can. J. Genet. Cytol.; 11: 937-47(Dec 1969).

Hereditary changes in the shape of the vertebral column in Lebistes reticulatus appeared after ancestral irradiation of immature germ cells with 500 or 1000 R of x rays. Although the mutant to wild-type ratios in the F_2 generation after outcrossing fitted a digenic and a trigenic segregation ratio, respectively, the quantitative characters in question are assumed to be caused by recessive mutations of polygenes which are highly mutable. (auth) (Canada)

23159 SENSITIVITY OF VARIOUS GERM-CELL STAGES OF THE MALE MOUSE TO RADIATION INDUCED TRANSLOCATIONS. Leonard, A.; Deknudt, Gh. (CEN, Mol, Belgium). Can. J. Genet. Cytol.; 10: 495-507(Sep 1968).

Adult male BALB/c mice were given whole body x irradiation with 300 R. Directly after x irradiation each male was mated to one virgin female of the same strain and received one fresh female per week during 9 weeks. The male F1 offspring was killed when mature and the testes removed and analyzed for the presence of chromosome rearrangements at diakinesis — first metaphase stage of meiosis. Whereas no aberration was recorded among the 171 F1 ♂ ♂ from the control series, chromosomal abnormalities were observed in 41 F1 ♂ ♂ from the irradiated series. The incidence of males with aberrations was respectively 5.1% the first week, 10.4% the second week, 21.7% the third week, 2.2% the fourth week, and 6.3% the fifth. No aberration was observed in the 129 F1 males sired between the sixth and ninth weeks. It may be concluded that irradiated spermatids yield approximately four times as many cases of aberration in viable F1 ♂ ♂ as do irradiated mature spermatozoa and about ten times as many as the most mature spermatocytes whereas no aberrations were recovered from irradiation of the spermatogonia. The most common aberrations found in the F1 males of the irradiated series were the reciprocal translocations. (auth) (Canada)

23160 RADIATION-INDUCED SPERMATOGONIAL EXCHANGE BETWEEN THE X AND Y CHROMOSOMES IN THE GUPPY. Schroeder, J. H. (Society for Radiation Research, Neuherberg, Ger.). Can. J. Genet. Cytol.; 11: 948-54(Dec 1969).

Irradiation of male germ cells in newborn guppies, Lebistes reticulatus Peters, caused an increase in the exchange frequency between the X and Y chromosomes in comparison to unirradiated controls among the offspring of the irradiated males, provided the offspring are produced during an interval between 161 and 283 days after irradiation. No significant increase of crossing-over frequency was obtained among offspring produced during the interval between 59 and 145 days after irradiation. It is concluded that irradiation of early spermatogonia (59 to 145 days postirradiation) does not increase the exchange frequency between sex chromosomes whereas the irradiation of stem cells (161 to 283 days) provides a significantly higher incidence of crossing-over events in the irradiated series than in the controls. The excess of crossovers in the irradiated stem cells of spermatogenesis is due only to clusters of crossovers in the irradiated series, since on excluding the clusters no difference between irradiated and control series could be found. (auth) (Canada)

23161 RADIATION-INDUCED MUTANTS OF DAHLBOMINUS FUSCIPENNIS (HYMENOPTERA: EULOPHIDAE). Baldwin, W. F.; Knight, P. A.; Chant, G. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Genet. Cytol.; 11: 823-8 (Dec 1969). (AECL-3444).

Thirteen new mutations of D. fuscipennis are described, bringing the number of mutants described for this species to 25. All the mutations in the haploid males were recessive and arose from irradiation of unmated wild females. Of the 13 mutations, 2 affect eye pigment, 2 body colour and 9 produced morphological changes in the antennae, head, eyes, wings, and abdomen. Three of the morphological abnormalities, small head, large eyes, and stumpy abdomen, did not segregate equally, probably due to lowered viability. (auth) (Canada)

23162 CHROMOSOME EXCHANGE DOSE-RESPONSE CURVE SATURATION AND DISTORTION IN TRADESCANTIA. Savage, John R. K. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 8: 668-70(Nov-Dec 1969).

In Tradescantia paludosa, the dose-response curve for chromosome exchanges (dicentrics and centric rings) produced by fast neutrons shows clear evidence of saturation at higher doses; this has been interpreted as evidence for a limited number of intranuclear sites for these aberration types. A study was made to derive coefficients of distortion and use them to predict the form of the dose-response curve expected with neutron irradiation. Coefficient values are given in a table for both the linear and quadratic aberration production. It is concluded that the discrepancy between the neutron and x-ray curves with regard to saturation, which was interpretated on the basis of differences in number of exchange sites, may equally well be explained in terms of the different effects of distortion on a basically linear and a basically quadratic dose-response curve. (C.O.)

23163 COORDINATE NONDISJUNCTION OF Y AND FOURTH CHROMOSOMES IN IRRADIATED COMPOUND-X FEMALE DROSOPHILA. Parker, D. R. (Univ. of California, Riverside). Mutat. Res.; 9: 307-22(Mar 1970).

Irradiated compound-X females having a Y chromosome produce triplo-4 offspring in higher frequency than did similar females lacking a Y chromosome, and the ratio of the sexes among the triplo-4 exceptions is quite different in the two cases, being approx. 4 ♂♂ : 1 ♀ in the former and 30 ♂♂ : 1 ♀ in the latter. The majority of triplo-4 males were found to have no free Y, hence the nondisjunctional diplo-4 eggs were most often nullo-X-nullo-Y. This condition was predicted by a model of Y-4 interchange as the initiating event of radiation-induced nondisjunction of chromosomes that are not ordinarily conjoined in bivalents by chiasmata. The analysis of a number of exceptions bearing Y fragments capped by a marked arm of chromosome 4 confirms that the segregations of the homologue of the broken 4 and of the compound-X, following Y-4 interchange, are such as to give the observed excess of males among the triplo-4 offspring. (auth)

23164 FATE OF DONOR DNA IN SOME POORLY TRANSFORMABLE STRAINS OF HAEMOPHILUS INFLUENZAE. Kooistra, Jan; Venema, Gerard (Univ. of Groningen, Netherlands). Mutat. Res.; 9: 245-53(Mar 1970).

Poorly transforming strains of Haemophilus influenzae were isolated by selection for sensitivity to mitomycin C. Three were studied in more detail with respect to their sensitivity to uv irradiation, mitomycin C and temperature, transformation efficiency, and the fate of donor DNA after uptake. All the mutant strains were temperature-sensitive at 42°. Two strains were as uv-resistant as the wild-type, and one strain was highly sensitive to uv irradiation and showed an increased sensitivity to mitomycin C. The mutant strains transformed about 700-fold less than the wild-type, although the amount of irreversibly fixed DNA was of the same order of magnitude as in the wild-type. However, recombinant marker activity, defined as molecules carrying both donor and recipient markers, was only 20 to 60% lower in the mutant strains than in the wild-type. The kinetics of the appearance of recombinant marker activity in the mutant strains and wild-type were almost similar. These results can be explained by assuming either that the mutants integrate the donor DNA incompletely or otherwise aberrantly; or, if integration should be normal, that they fail to express the donor phenotype. (auth)

23165 INDUCTION BY UV-LIGHT OF SECTORED AND NON-SECTORED PETITE MUTANTS OF SACCHAROMYCES CEREVISIAE. Mayer, V. W. (Food and Drug Administration, Washington, D. C.). Mutat. Res.; 9: 255-60(Mar 1970).

The production by uv-light of petite mutants of Saccharomyces cerevisiae was observed by the tetrazolium dye reduction method. The total mutant population, which rose exponentially as the 1.86 power of the dosage, was divided into two classes based on the appearance of the colonies after treatment with the tetrazolium overlay. One class, in which the entire colony failed to reduce the dye (non-sectored) and remained white, rose as the square of the dosage. The other class, in which only a portion of the colony reduced tetrazolium to produce a red color (sectored), rose in proportion to the dosage. These results were interpreted to show that sectored and non-sectored mutants induced by uv-light follow single and two-hit kinetics, respectively. The two events leading to a non-sectored mutant are not identical to two of the single events leading to a sectored mutant acting in concert. Furthermore, the kinetic model presented can be explained by assuming that lethal sectoring is the mechanism responsible for the second of the two events required for a non-sectored mutant colony. (auth)

23166 STUDIES ON THE MUTAGENIC ACTION OF N-METHYL-N'-NITRO-N-NITROSOGUANIDINE IN PARAMECIUM AURELIA WITH EMPHASIS ON REPAIR PROCESSES. Kimball, R. F. (Oak Ridge National Lab., Tenn.). Mutat. Res.; 9: 261-71(Mar 1970).

In Paramecium aurelia, N-methyl-N'-nitro-N-nitrosoguanidine (MNNG) — like x-rays, uv light, triethylene melamine (TEM), and nitrogen mustard (HN_2) — induces a maximal mutation yield if the paramecia are exposed at or just before the onset of DNA replication and little if any mutation when exposed just after replication. For MNNG, this period of very small or zero yield extends through mitosis and cytokinesis. The rate of repair as judged by the rate of increase in yield with increasing time between division and exposure during the G_1 period is appreciably greater than with either

x rays or TEM. Unlike the case with the other mutagens, streptomycin treatment begun immediately after exposure to MNNG, does not consistently decrease the mutation yield. Instead, a streptomycin treatment begun later during replication, increases the yield. The interpretation is made that MNNG, like the other mutagens, induces premutational damage that can be repaired up to the time of replication and is only then fixed as final mutation. The different response to streptomycin is interpreted, not as a basic difference between the mutagens, but as a consequence of the high rate of repair with MNNG. This could allow the inhibition of repair by streptomycin, which probably occurs for the other mutagens as well, to balance or overbalance the increased time for repair resulting from inhibition of DNA synthesis. (auth)

23167 X-RAY-INDUCED RECOMBINATION IN THE FOURTH CHROMOSOME OF DROSOPHILA MELANOGASTER FEMALES. I. KINETICS AND BROOD PATTERNS. Williamson, J. H.; Parker, D. R.; Manchester, W. G. (Univ. of California, Riverside). Mutat. Res.; 9: 287-97(Mar 1970).

X-ray-induced recombination in the fourth chromosome exhibited a greater than linear dose-response and occurred predominantly in the heterochromatic regions spanning the centromere. In brooding experiments recombinant fourth chromosomes were recovered in all broods with no apparent relationship between the recovery of recombinant chromosomes and the recovery of triplo-4 and detachment-bearing progeny. There was no evidence of clustering in either early or late broods. We have concluded that x-ray-induced recombination is a translocation-like process involving homologues. (auth)

23168 X-RAY-INDUCED RECOMBINATION IN THE FOURTH CHROMOSOME OF DROSOPHILA MELANOGASTER FEMALES. II. SEGREGATIONAL PROPERTIES OF RECOMBINANT FOURTH CHROMOSOMES. Williamson, J. H.; Parker, D. R.; Manchester, W. G. (Univ. of California, Riverside). Mutat. Res.; 9: 299-306(Mar 1970).

X-ray-induced recombinant fourth chromosomes exhibited a wide range of nonrandom associations with the reversed metacentric compound-X chromosome in C(I)RM/o females. The addition of a Y chromosome altered the degree of association, often randomizing segregation of the recombinant fourth chromosome and the compound-X. In some cases, however, the addition of a Y chromosome caused the recombinant fourth chromosome and the compound-X chromosome to segregate together less often than random. We have concluded that x-ray-induced recombination is an interchange process involving breakage and rejoining of homologues. These breaks need not be precisely between homologous loci and may lead to small duplications and deficiencies. Therefore an induced crossover chromosome is in reality a kind of half-translocation. Whether the observed variations in nonrandom associations are due to differences in mere size or differences in genetic content of the centric regions of the recombinant chromosome is problematical. (auth)

23169 PIGMENT MUTATIONS OF CHLAMYDOMONAS REINHARDI INDUCED BY N-NITROSOETHYLUREA AND BY UV-IRRADIATION. Ladygin, V. G. (Inst. of Biological Physics, Puschino-on-the Oka, USSR). Genetika; 6: No. 3, 42-50(Mar 1970). (In Russian).

Nitrosoethylurea and uv irradiation exerted strong mutagenic effects on cells of Chlamydomonas reinhardi. These mutagens both induce visible mutations of any type. Nitrosoethylurea, however, induced a higher level of pigment mutations. The highest yield of mutations was obtained at the dose of uv irradiation at which 10 per cent of cells survive. Photoreactivation reduce both lethal and mutagenic action of uv irradiation. (auth)

23170 INDUCTION OF MUTANTS RESISTANT TO YELLOW STRIPE RUST IN THE "DIANA I" WINTER WHEAT VARIETY. Hanis, M.; Knytl, V.; Jech, Z. (Main Specialized Breeding Station for Mutation Breeding, Stupice, Czech.). Genet. Slechteni; 5: 257-62(Dec 1969). (In Czech).

Dry seeds of the Diana I winter wheat variety were acutely irradiated with a 23,000 R dose of γ rays. With the use of the pedigree method in the M_2 to M_5 generations, 15 mutants resistant to yellow stripe rust were obtained. This corresponded to a frequency of 0.11% of the number of progenies in the M_2 generation, or 0.01 mutation to 100 plants in the M_2 generation. These are generally macromutations. Mutant Nr. 1 (SD 69-68) has the prerequisites for direct utilization as a variety, and is now being tested in eight workplaces in Bohemia and Moravia. Individual mutations have split off in generations M_2 to M_5. (auth)

23171 MODIFICATION OF X-RAY RADIATION EFFECTS BY MEANS OF CHEMICAL SUBSTANCES. Langer, I. (Chief Specialized Plant Selection Station, Stupice, Czech.). Genet. Slechteni; 5: 17-22(Mar 1969). (In Czech).

The influence of cysteine urea, and thiourea on the radiosensitivity and mutability of spring barley, variety Valticky, was studied. The seeds were steeped in a solution of the mentioned substances and then x-irradiated to doses of 1000 R, 2500 R, and 4000 R. The greatest protective effect in the M_1 generation was provided by urea, especially at higher doses of radiation. The sterility of the ears in the M_1 generation after the application of the protective substances in combination with lower radiation doses was greater than in control specimens subjected to radiation without protective substances. In combination with higher doses of radiation, the sterility of the ears of the M_1 generation was the same as that of the control specimen. All the substances used lowered the frequency of chlorophyll mutation in the M_2 generation per 100 ears of M_1 and the frequency of chlorophyll mutation per 100 plants of M_2. (auth)

23172 CHANGES IN THE GRAIN QUALITIES OF THE WINTER WHEAT VARIETY SALZMUENDER BARTWEIZEN CAUSED BY MUTAGENS. Jech, Z.; Hanis, M.; Rejman, B.; Langrova, M.; Hodova, H. (Chief Specialized Plant Breeding Station for Mutation Selection, Stupice, Czech.). Genet. Slechteni; 5: 29-35(Mar 1969). (In Czech).

The dry seeds of the wheat variety Salzmünder Bartweizen were subjected to an intense dose of x rays, 15,000 R, or to EMS (0.31% water solution). After repeated selection of ears with higher grain qualities the average degree of swelling of the gluten in the population of irradiated seeds in the X_3 generation improved to 2.43 compared with that of the control, 0.63. Similar results were obtained after subjecting the seeds to EMS. During the selection in M_2, the swelling capacity in the M_4 generation rose to 2.07, and after one-year, single-grain reseeding by the so-called ramsch method, the degree of swelling in the same generation was as much as 1.87 and 1.14 in the same generation as opposed to 0.63 for the control. By means of electrophoresis, it was shown that the mutant with the grain of a better quality had a different protein composition. (auth)

23173 ENHANCING NEUTRON GENETIC EFFICIENCY BY INFRARED IRRADIATION. Turbina, L. N. (Inst. of Genetics and Cytology, Minsk). Dokl. Akad. Nauk BSSR; 14: 65-7(Jan 1970). (In Russian).

Effects of infrared irradiation on neutron-induced genetic modifications were studied using E. coli exposed to neutrons with 0.2 0.4 MeV energies. Tests made with preparations of the donor (Hfr-C) irradiated with infrared light before and after the exposure to 0.2 MeV fast neutrons for 1.5 hr showed increased recombination. The data confirmed the postulation that infrared light enhanced the neutron-induced damage in Hfr-C chromosomes; this aids recombination in the recipient cell. (R.V.J.)

23174 RADIOSENSITIVITY OF THE CHROMOSOMES OF MONKEY (MACACA MULATTA) PERIPHERAL-BLOOD LEUCOCYTES AT THE DIFFERENT STAGES OF THE MITOTIC CYCLE. Dzhemilev, Z. A. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Genetika; 6: No. 4, 147-55(Mar 1970). (In Russian).

Cultures of monkey peripheral-blood leukocytes were irradiated by a 100 R dose of x rays at the G_1, S, and G_2 stages of the cell cycle. The frequency of chromosome aberrations was determined on metaphase cells. The data obtained showed that the greatest number of chromosome aberrations was induced in the cells irradiated at the G_2 stage. Cells irradiated at the S stage and early G_1 stage are more radioresistant. Cells irradiated at the late G_1 stage had more aberrations than those irradiated at the stage S. Among the aberrations induced by irradiation at the stage G_1, aberrations of the chromosome type prevailed, although some aberrations of the chromatid type were also observed. Most of the aberrations induced at the stage G_2 were of the chromatid type. (auth)

23175 CHROMOSOMAL ABERRATIONS INDUCED IN MERISTEMATIC REGIONS OF THE EMBRYOS IN X-IRRADIATED DRY SEEDS OF VICIA FABA. Miah, A. J.; Brunori, A. (Centro Studi Nucleari della Casaccia, Rome). Radiat. Bot.; 10: 87-94(Feb 1970).

The embryonic meristems (root, epicotyl and leaf primordia) of dry seeds of Vicia faba consist of cell populations with different 2C/4C cells ratios. The 4C cells are more frequent in the root meristem (10.85 per cent) than in the epicotyl (5.10 per cent) and leaf primordia, in which they are extreme rare (0.05 per cent). When dry seeds are X-irradiated (1500 R), the highest radiosensitivity is shown by the root meristem, probably due to the highest frequency of 4C cells in this meristem. The epicotyl and leaf primordia show a comparable radiosensitivity and radiation damage constant with time, probably due to uniformity in cell population. (auth) (UK)

23176 INDIVIDUAL AND COMBINED INFLUENCE OF RADIATION AND INHIBITORS OF PROTEIN AND DNA SYNTHESIS

ON THE CELLS OF CREPIS CAPILLARIS. Mitrofanov, Yu. A.; Kotomina, I. F. (Inst. of General Genetics, Moscow). Genetika; 6: No. 3, 18-29(Mar 1970). (In Russian).

Modification of chromosome and chromatid aberrations was found to appear in the different phases of the mitotic cycle. The former were modified in G_1 and S, while the latter in S and G_2. It is apparently connected with the production of the chromosome aberrations in the S phase (possibly just before the DNA synthesis in a chromosome) and the chromatid aberrations, in G_2 (probably just before the mitosis). FUDR-induced modification of the radiation effect was followed by chromosome fragmentation, which accounted for the changes in the aberrations spectrum. A very appreciable effect was noted for the chromatid aberrations whereas for the chromosomes it was less pronounced. The mutagenic and modifying effect of FUDR was in accordance with the rate of DNA-synthesis in the cell. The strongest FUDR effect was noted only when the following three events were synchronized: irradiation, DNA synthesis in the cell, incorporation of an inhibitor. In this case one could observe the extra FUDR effect on the radiation-induced chromosome damages. Pyromycin considerably increased the chromosome aberration number in irradiated cells, but failed to change their spectrum. The strongest activity of the chemical was noted for the cells in G_1 and G_2. It was less active in the S-phase. (auth)

23177 EFFECT OF HEAT TREATMENT AND ANAEROBIC HYDRATION ON THE RADIOSENSITIVITY OF PEAS. Balint, A.; Mehandgiev, A.; Sutka, J. (Coll. of Agriculture, Goedoelloe, Hungary). Acta Agron. Acad. Sci. Hung.; 17: No. 1-2, 223-9 (1968).

In order to study how the mutation process can be controlled, the air-dried seeds of Pisum of Petit Provencal variety, were kept in a drying chamber at a temperature of 60 ± 1° C for 24 hours, then they were treated with an 8,000 R and 11,000 R dose of x rays. After irradiation anaerobic hydration at a temperature of 50 ± 1° C was done. The hydration following the heat treatment and irradiation increased the relative percentage of germination of the seeds and the average length of seedlings. The temperature and the anaerobic conditions in mitotic cells reduced the frequency of anaphases with chromosome bridges and fragments. As the result of the cumulative effect of the two factors less chromosome aberrations could be observed with an 11,000 R dose of x rays than with a dose of 8,000 R when the seeds were untreated with secondary factors. (auth)

Health Physics and Safety

Refer also to abstracts 22574, 22735, 22878, 22884, 22892, 22894, and 22926.

Radioactive Contamination and Decontamination

Refer also to abstracts 22792, 22844, 22845, 23128, 23129, 23132–23134, 23136, 23137, 23140, 23152, and 23155.

23178 (HASL-220) INVESTIGATION OF THE RADIOLOGICAL CHARACTERISTICS OF URANIUM MINE ATMOSPHERES. Breslin, A. J.; George, A. C.; Weinstein, M. S. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Dec 1969. 143p. Dep. CFSTI.

Radiological characteristics of the environments of nine representative uranium mines were studied by survey teams equipped to collect and analyze samples underground. Spatial and temporal variations of radon concentration, working level, and radon daughter ratio were investigated for three to four days in each mine by obtaining consecutive measurements at typical locations and operations. Additional measurements included γ radiation, ore dust concentration, temperature, relative humidity, barometric pressure, and ventilation rate. Data are summarized and discussed in the text, and detailed in three appendices. (auth)

23179 (INR-1114) RADIOACTIVE CONTAMINATION OF THE AREA AND THE ENVIRONMENT OF THE INSTITUTE OF NUCLEAR RESEARCH, ZERAN CENTRE, IN THE PERIOD 1961–1967. Cwik, Tadeusz; Gorberg, Zofia; Jaskulski, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1969. 29p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Radioactive contamination of the area and environment of the Institute of Nuclear Research–Zeran Centre in the period 1961 to 1967 was investigated. The radioactivity of soil, grass, corn, waters, and wastes were studied. A comparison was made between natural background radiation and the effects of the Institute on the biosphere. (H.B.G.)

23180 (NIRS-RSD-20) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of Radiological Sciences, Chiba (Japan)). Aug 1968. 16p. Dep. CFSTI (U. S. Sales Only).

Radioactivities measured in milk, powdered milk, vegetables, total diet, and the standard diet in Japan are given. Milk samples from 25 public health laboratories were analyzed for ^{90}Sr and ^{137}Cs in Japan Analytical Chemistry Research Institute. Powdered and skim milk samples from open markets and producers were analyzed for ^{90}Sr and ^{137}Cs in Japan Analytical Chemistry Research Institute. Vegetable samples taken twice during the harvest time in 12 prefectures were analyzed for ^{90}Sr and ^{137}Cs in Japan Analytical Chemistry Research Institute; only the edible parts were analyzed. Total-diet samples, collected from 24 prefectures, were analyzed for ^{90}Sr and ^{137}Cs in National Institute of Radiological Sciences and Japan Analytical Chemistry Research Institute; one city and one village was chosen in each prefecture. The total diet was a normal one in the city or village. Standard-diet samples collected in four prefectures were analyzed for ^{90}Sr and ^{137}Cs in National Institute of Radiological Sciences; cereals, milk, eggs, meat, fish, vegetables, etc. were diet components. (NSA of Japan)

23181 (NIRS-RSD-21) RADIOACTIVITY SURVEY DATA IN JAPAN. (National Inst. of radiological Sciences, Chiba (Japan)). Nov 1968. 12p. Dep. CFSTI (U. S. Sales Only).

Radioactivities measured in soil, water, human body, and diet in Japan are given. Surface soil samples, collected from 16 prefectures, were analyzed in Japan Analytical Chemistry Research Institute, to determine the deposits of fallout (^{144}Ce, ^{137}Cs, and ^{90}Sr). Potable rain-water samples, collected in eight prefectural public health laboratories, were analyzed for ^{90}Sr and ^{137}Cs in Japan Analytical Chemistry Research Institute. Potable rain-water samples from eight lighthouses were analyzed for ^{90}Sr and ^{137}Cs in the same Institute; the samples were both with and without filtration by sand or charcoal. Bone samples, from the deceased in Tokyo, were analyzed for ^{90}Sr in the National Institute of Radiological Sciences. Total body burden of ^{137}Cs as assessed by blood analysis; citrated whole-blood samples supplied by blood banks etc., both in Japan and overseas countries, were analyzed for ^{137}Cs in the Institute of Public Health. Tea samples sent by three public health laboratories were analyzed for ^{90}Sr and ^{137}Cs in Japan Analytical Chemistry Research Institute; tea leaves were dried to ashes before analysis. (NSA of Japan)

23182 (NP-18100) ^{90}Sr IN THE AUSTRALIAN ENVIRONMENT DURING 1968. Gibbs, W. J. (Atomic Weapons Tests Safety Committee, Victoria (Australia)); Matthews, W. K. (United Kingdom Atomic Energy Authority, Capenhurst (England). [Production Group]); Moroney, J. R.; Stevens, D. J.; Titterton, E. W. (Atomic Weapons Tests Safety Committee, Victoria (Australia)). 1969. 28p. Dep. CFSTI (U. S. Sales Only).

An Australia-wide survey of ^{90}Sr in global fallout was done, especially with reference to the passage of ^{90}Sr through food chains to human bone tissue. Results are presented for 1968, during which year the French exploded two nuclear devices in the megaton range in the South Pacific. The mean deposit of ^{90}Sr with rain and as dry fallout was the lowest for any year since monitoring began in 1958. Fallout from tests in Polynesia contributed significant fraction of the total ^{90}Sr deposit towards the end of 1968. The mean ratio of $^{90}Sr/Ca$ in total diet for the year continued its downward trend. Results confirm that fallout over Australia from all nuclear weapons tests up to 1968 constitutes no significant hazard to the health of the Australian population now or in the future. (Australia)

23183 (NP-18122, pp 105-25) HANDLING OF RADIOACTIVE MATERIAL. (Bundesminister fuer Wissenschaftliche Forschung, Bonn (West Germany)). (In German).

Findings obtained with personnel dosimeters, measurements of radioisotope incorporation, and compilation of cases involving possible radiation injury were presented in seventeen tables and graphs. 21000 persons, handling radioisotopes professionally, were monitored during 1968. Excess above the maximum permissible dose was rare. About 0.6% of the monitored personnel showed more than 3 rem/13 weeks or 5 rem/year. These overexposed persons represented less than one per million of the total German population. During 1968, 163 incorporations occurred accidentally. 22 of these exceeded the maximum permissible dose and were caused by tritium. Tritium incorporation occurred in persons employed by research institutions and especially in workers employed in plants manufacturing luminescent paints. Lack of experience and training was the main factor for overexposure and corrective measures were proposed. (H.B.G.)

23184 (NP-18195) EXPERIMENTAL STUDY AND NUMERICAL MODEL OF THE RADIOACTIVE EQUILIBRIUM BETWEEN RADON AND ITS SHORT-LIVED DAUGHTERS IN URANIUM MINES. Chabot, Alain (Toulouse Univ. (France)). 1970. 93p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

Various measurement methods of the radioactive equilibrium between radon and its short-lived daughters in uranium mines are presented. A calculation of the error associated with each measurement makes it possible to deduce the best experimental conditions and to compare them. The spectrometric method (two countings) and the method of measurement of the total activity (three countings) give satisfactory results. The results of many experimental measurements are given in the form of histograms. A numerical model simulating the circulation of air in the mine roads and giving the evolution of the radioactive equilibrium at each point as a function of the mine road lengths, ventilation rates and radon sources is then presented. A good agreement between the theoretical and the experimental results is obtained. (France)

23185 (ORNL-TM-2862) FIFTH QUARTERLY PROGRESS REPORT ON THE THEORETICAL EVALUATION OF CONSUMER PRODUCTS FROM NUCLEARLY STIMULATED GAS WELLS. Jacobs, D. G.; Kelly, M. J. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The concentrations of tritium and ^{85}Kr in the products being removed from the Gasbuggy cavity are dropping exponentially as a function of the cumulative volume of gas removed from the cavity. The chemical composition of product being removed at the wellhead also shows that mixing with formation fluids is occurring. Tritium appears to be rather uniformly distributed among all hydrogen-bearing components. Analytical requirements for the product from the Rulison cavity are outlined on the basis of these historical radiochemical and chemical data for the products removed from the Gasbuggy cavity. (auth)

23166 RETENTION OF RADIOCESIUM IN CROP PLANTS IN YEARS 1963–1967. Csupka, Stefan; Carach, Jozef; Petrasova, Maria (Regional Hygienic Station, Bratislava). Biologia (Bratislava); 24: 645-52(1969).

The contents of ^{137}Cs in wheat and barley have been followed for a period of five years. The radioactivity level in crop plants is affected above all by the intensity of the fallout. While the content of radiocesium present in fallout in the year 1967 dropped by 95%, as compared with the year 1963, its content in wheat and barley in the same period dropped by 86% and 90%, respectively. Of all the tested species of wheat cultivated in Slovakia in 1966, those at Košuty and Pavlovice showed ca 20 to 30% higher contents of radiocesium than did the other species. It was of course found that the retention of radiocesium by crop plants was affected by the amount of it contained in the fallout, but it was not less evident that soil and meteorological factors play important roles. (auth)

23187 TESTING OF FOOD SUPPLIES AND POTABLE WATER FOR RADIOACTIVE SUBSTANCES FROM THE STANDPOINT OF MILITARY MEDICINE. Denbsky, G. Wehrmed. Monatsschr.; 12: 352-5(1968). (In German).

A radioactive-chemical separation process is described for the determination of radioactivity in food. The process may be accelerated by knowingly accepting the losses of the sought radioactive substances, after the addition of a known amount of inactive carrier-substance, and by determining the percentage of the carrier value at the end of the analysis. The radioactive-chemical result is identical to the chemical result. If, in urgent cases involving food supplies, the determination in the picocurie-range is foregone, then considerably smaller samples will be adequate and the time required for drying and incineration, as well as the measurement times, will be correspondingly shorter than is the case if one is working at the low present activity range. The distribution of the test material in a thin layer on V2A-sheet metal permits shortening the time to the availability of the raw ash to 60 minutes with a few food materials. For the evaluation of this method, the tracer-technique observation of every analytical step by direct γ-determination is of considerable value. For radioactive strontium, the γ-ray-emitter ^{85}Sr was found useful as a radioactivity indicator. (TSS)

23188 SEWAGE SLUDGE CONDITIONING AND DISINFECTION BY GAMMA IRRADIATION. Etzel, James E.; Born, Gordon S.; Stein, Jerome; Helbing, Thomas J.; Baney, George (Purdue Univ., Lafayette, Ind.). Amer. J. Public Health; 59: 2067-76(Nov 1969).

Gamma irradiation is used for high degrees of bacterial disinfection at doses around 200,000 rads. Concurrent with the disinfection dosage it is possible to effect an increased filterability if the material irradiated is digested waste-activated sludge. If the material irradiated is waste-activated sludge, the optimum dosage for disinfection is the same as the optimum dosage to bring about a two to threefold increase in settleability. (auth)

23189 THE CONTENT OF ^{90}Sr IN THE DRIED MILK SUNAR (NOVY BYDZOV) IN THE YEARS 1962 TO 1967. Giacintov, P.; Zima, S. Cesk. Hyg.; 13: 580-3(1968).

Results are reviewed of ^{90}Sr contents of dried milk produced between 1962 and 1967. The maximum values of ^{90}Sr in milk were found in samples from August 1963 (29.4 pCi/g Ca). Monthly mean values are tabulated. From the beginning of 1964 the level of ^{90}Sr in milk decreased; it maintained values in relation to the deposit in soil (10 to 15 pCi/g Ca). These values are considered as being in equilibrium. (Excerpta Med.)

23190 EXPERIENCE IN THE STUDY OF ^{131}I CONTENT IN THE AIR OF A RADIOLOGICAL DEPARTMENT. Golikov, V. Ya.; Bakulina, L. A. (Central Inst. for Medical Graduate Studies, Moscow). Gig. Sanit.; No. 6, 111-12(Jun 1969). (In Russian).

The content of ^{131}I in the radiological department did not exceed the maximum permissible dose (9×10^{-13} Ci/l). Measures for preventing higher contamination (by iodine evaporation from open solution or surfaces, hermitization of containers with highly active solution) were suggested as well as careful decontamination of surrounding equipment. (R.V.J.)

Dosimetry and Monitoring

Refer also to abstracts 22988, 23002, 23023, 23131, 23145, 23147, 23276–23278, 23295, 23361, 23362, and 24106.

23191 (BNWL-1183-3) THE MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, October 6, 1969–January 4, 1970. Brodzinski, R. L.; Rancitelli, L. A.; Haller, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Jan 1970. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

The urine and feces specimens from the Apollo 11 mission were analyzed for their radionuclide content. Estimates of cosmic radiation dose received by the astronauts were difficult to determine due to decay of the short-lived radionuclides during quarantine. The concentrations of ^{7}Be, ^{22}Na, ^{40}K, ^{59}Fe, ^{60}Co, and ^{137}Cs were determined. No ^{147}Pm was observed in any of the samples. The concentrations of 16 major, minor, and trace elements were determined in fecal samples from Apollos 8 and 10. Large discrepancies between the excretion rates and normal dietary intakes were noted for Co, Fe, Sn, and K. An interpretation of the hazards these deviations may produce requires the determination of the elemental concentrations of the foodstuffs used during these missions. The fecal samples from the Apollo 11 mission were analyzed for glass fiber content. One anomalous sample was observed having a glass fiber content twofold greater than any previously measured specimen. A piece of the outer thermal coating of the Apollo 12 spacecraft was analyzed for cosmic-ray-induced radioactivity. Beryllium-7 was observed. (auth)

23192 (CONF-690501–, pp 89-96) RADIATION DOSE TO FETUSES OF MINIATURE SWINE INGESTING ^{90}Sr. Palmer, R. F.; Watson, C. R.; Beamer, J. L. (Battelle Memorial Inst., Richland, Wash.).

Radiation-dose measurements with thermoluminescent dosimeters demonstrated that during the second half of fetal life critical tissues in the fetuses of miniature swine ingesting ^{90}Sr daily receive radiation from their own ^{90}Sr–^{90}Y only, not from their dams. Dose rates calculated from ^{90}Sr concentrations agree well with directly measured rates and point out 100-fold differences in the average dose rates to different, potentially critical tissues. Results from the chronic ^{90}Sr feeding experiment continue to suggest that fetal exposure to this radioisotope plays an important role in the subsequent development of hematopoietic neoplasms in these miniature swine. (auth)

23193 (CONF-690501–, pp 105-16) ESTIMATION OF INTERNAL DOSE IN HUMAN FETUS AND NEWBORN INFANTS DUE TO FALLOUT ^{137}Cs. Iinuma, T. A.; Yashiro, S.; Ishihara, T.; Uchiyama, M. (National Institute of Radiological Sciences, Chiba, Japan); Nagai, T. (International Atomic Energy Agency, Vienna, Austria); Yamagata, N. (Institute of Public Health, Tokyo, Japan).

In view of the scarcity of data concerning the internal doses in human fetuses and newborn infants due to fallout ^{137}Cs, several experimental and theoretical studies were performed on fetal and infantile metabolism of this nuclide. In the experimental work, nine pregnant women at a month before partus and their placentas at partus were measured for their ^{137}Cs and K contents and the ratio of the average ^{137}Cs concentrations between mother and placenta was determined. Then, 10 newborn infants who were bottle fed were measured for their ^{137}Cs and potassium contents once a month from birth to 8-months old, and variation of the average ^{137}Cs content was observed as a function of age. Assuming the metabolic model of ^{137}Cs in the infant and knowing the ^{137}Cs concentration in powdered milk supplied, an average biological half-life for the 10 infants was calculated to be between 10 and

15 days. Formulas were developed to relate the ^{137}Cs concentration as a function of time and the internal dose of radiation. The doses received by fetuses, by infants who were either bottle fed or breast fed, and by mothers were calculated for the period between 1962 and 1966 using data obtained in Japan. The bottle-fed infants who consumed cow's milk could receive up to 10 times the radiation dose received by adult males, but the doses to fetuses and breast-fed infants were smaller than those to the adult. (auth)

23194 (EUR-4412) ENVIRONMENTAL RADIOACTIVITY: ISPRA, 1968. de Bortoli, M.; Gaglione, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 10 Sep 1969. 60p. Dep. CFSTI (U. S. Sales Only). EUR FF 7.75.

Measurements of environmental radioactivity at ISPRA performed during 1968 by the site survey group of the Protection Service are described. Data are given on the concentrations of strontium-90, cesium-137, and other radionuclides in fallout, air, soil, waters, herbage, animal bones and foods. (auth)

23195 (PEL-192) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report for the Year 1968. van As, D.; Fourie, H. O.; Vleggaar, Constance M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Sep 1969. 26p. Dep. CFSTI (U. S. Sales Only).

Measurements made during 1968 of gross radioactivities and certain individual nuclides in samples of soil, vegetation, water, sediment, waterplants, fish, milk, and agricultural products from the environment around the National Nuclear Research Centre (NNRC) at Pelindaba, are reported. Gross activities are compared with values of previous years and the results of fallout measurements are given. No increases in environmental radioactivity due to operations at the NNRC could be detected. (auth)

23196 (SWRHL-82, pp 550-84) METHODS OF ESTIMATING POPULATION EXPOSURES FROM PLOWSHARE APPLICATIONS. Kaye, Stephen V.; Rohwer, Paul S. (Oak Ridge National Lab., Tenn.).

When estimating doses to populations it is necessary to divide the total population into groups that have parameters of similar type and magnitude in order to identify critical population groups. Age groups constitute the most basic and generally useful way of dividing the total population for estimating dose. Models for estimating dose, particularly the internal dose from inhalation and ingestion of radioactivity, should be written as a function of age. The importance of considering age-dependency is emphasized by the fact that some of the internal dose parameters change by as much as a factor of ten for some radionuclides when comparing a one year old with an adult. A computer code called INREM was written that can consider all internal dose parameters as a function of age. The major limitation in using this computer code for all radionuclides is the paucity of age-dependent input data for many radionuclides. Tritium, iodine, cesium, and strontium were studied in detail with INREM and the results and interpretations are discussed. Another code, EXREM, computes the external dose rates and cumulative doses from both β particles and γ photons from submersion in a radioactive cloud, submersion in contaminated water, and exposure above a contaminated land surface. This code can consider up to 25 Plowshare detonations and a variety of combinations for calculating doses and dose rates in relation to a detonation schedule. The importance of using both INREM and EXREM to estimate the total dose to a population group is stressed. (auth)

23197 ANNUAL DOSES DETERMINED WITH STATIONARY AND PERSONNEL DOSIMETERS AT THE NUCLEAR RESEARCH CENTER KARLSRUHE. Kiefer, Hans; Piesch, Ernst (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie; 138: 696-8(Dec 1969). (In German).

For several years phosphate-glass dosimeters were used at the Karlsruhe Nuclear Research Center for measuring personnel and environmental exposure. Statistics were prepared for the year 1968. (auth)

23198 COMPUTATION OF DISTRIBUTION OF ABSORBED DOSE AND ABSORBED DOSE RATE FROM A SCANNING ELECTRON BEAM. Rozenfeld, Martin; Lanzl, Lawrence H.; Newton, Carol M.; Skaggs, Lester S. (Argonne Cancer Research Hospital, Chicago). Strahlentherapie; 138: 651-9(Dec 1969).

The electron linear accelerator at Argonne cancer research hospital was designed to scan small pencil-like beams over an arbitrarily shaped field, defined by a full template. The scanning device and the field resulting from a given template were depicted. To determine dose distribution and dose rate, computer programs were developed. (H.B.G.)

23199 DISTANCE TECHNIQUE FOR DECREASING SCATTER RADIATION DURING ROENTGENOGRAPHY. Gajewski, Heinz; Mueller, Dietmar (Siemens AG, Erlangen, Ger.). Strahlentherapie; 138: 689-95(Dec 1969). (In German).

The measurement of the effect of the distance between object and film on the scattered-radiation component leads to the following conclusions: The distance technique becomes equivalent to a scattered-radiation grid at long object-film distances only which are practically not applicable owing to excessively high geometric blurring. For high-kilovoltage chest radiography a scattered-radiation grid of low selectivity should be used instead of Groedel's distance technique. In radiography, applying a twofold geometric enlargement, the selectivity of the distance technique is sufficient up to object fields of 100 cm^2. Enlargement radiographs of moving objects should be taken without scattered-radiation grid. (auth)

23200 RADIATION FIELD DISTRIBUTION DURING HANDLING OF AN $^{87}Y/^{87m}Sr$ COLUMN AND OF ^{87m}Sr. Grebe, Siegfried Franz; Roemer, Manfred (Justus-Liebig-Univ., Giessen, Ger.). Strahlentherapie; 138: 685-3(Dec 1969). (In German).

The radiation emitted by a 5 mCi $^{87}Y/^{87m}Sr$ column and by ^{87m}Sr eluated was measured in various working and protection conditions. The dose emitted by the patients having received the ^{87m}Sr was also measured at various distances. Inevitably high exposures occur at the fingers when the solution is taken in the syringe and during the injection. (auth)

23201 RADIATION EXPOSURE IN SUPERSONIC TRANSPORT BY SOLAR FLARES. Allkofer, O. C.; Simon, M. (Univ., Kiel). Biophysik, 6: 113-22(1969).

Results of a theoretical analysis of the radiation exposure for solar proton beams and their secondaries in the altitude region of SST (supersonic transport) and pole regions are presented. The radiation dosage is calculated as a function of atmospheric depth for several characteristic flares. The dosage in rems from secondary neutrons exceeds the dosage in rems from protons in the altitude region of SST for flare events with low characteristic slope parameter G. In general the radiation is, without some rare extreme events, beyond dangerous limits and the rare extreme exposure values will be of some hundred mrem/h. (auth)

23202 AUTOMATIC LAUNDRY MONITOR AS A TOOL FOR KEEPING THE CONTAMINATION LEVEL WITHIN PRESCRIBED LIMITS. Vaane, J. P.; De Ras, E. M. M. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Health Phys.; 17: 729-30(Nov 1969).

Working clothing worn in active laboratories of the European Institute for Transuranium Elements is changed weekly and is monitored by an automatic laundry monitor described elsewhere. Clothing items are numbered and attention of the health physicists is drawn to areas from which contaminated items originate. In this way useful information about working habits and contamination in laboratories is obtained. Experience with this system has justified a reduction by a factor of three in the frequency of routine floor monitoring and smear tests. (UK)

23203 ASSESSMENT OF RADIATION WORKING CONDITIONS IN THE MINING OF NONRADIOACTIVE ORE BY MEANS OF DOSIMETRY OF LUNG IRRADIATION JUDGING BY γ IRRADIATION OF THE CHEST. Alterman, A. D.; Ruzer, L. S.; Urusov, S. A. (All-Union Scientific-Research Inst. of Physical and Radio Engineering Measurements, Moscow). Gig. Sanit.; No. 6, 53-8 (Jun 1969). (In Russian).

The radiation working conditions prevailing at a polymetallic mine were studied in the course of a geological survey of underground excavations that revealed the daughter products of radon at a concentration of 10^3 to 10^6 MeV/l. The absorbed doses was assessed by means of determining the dose to the lung from γ irradiation of the chest. A total of 168 workers were examined in the course of a shift. The doses fluctuated from 10 to 400 millirem. In 25 workers examined during a week, the total doses amounted to 104 to 1156 millirem. The advantages of the above-mentioned method in comparison with the method of calculating the dose according to concentrations is demonstrated. (auth)

23204 MEASUREMENTS OF ABSORBED DOSES BY A TRACHEA MODEL PLACED IN RADON-CONTAINING ATMOSPHERE OF A POLYMETAL MINE. Kirichenko, V. N.; Ivanov, V. D. Gig. Sanit.; No. 1, 66-71(Jan 1970). (In Russian).

By means of a specially elaborated method and apparatus doses of α radiation of short-life daughter products of radon were measured on the internal surface of a trachea model in various parts of polymetal mines. Simultaneously, the level of latent energy and the content of free radium atoms in the atmosphere were monitored. The doses determined in the models correlated sufficiently with the content of free atoms. However, no definite relation could be found between the doses in the model and the level of latent energy. (auth)

23205 EFFECT OF THE DETECTORS' SIZE ON THE ACCURACY OF THE DOSE FIELD DETERMINATION. Denisenko, O. N.; Il'ichev, B. V.; Kozlov, V. A. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 15: No. 1, 67-72(Jan 1970). (In Russian).

An analysis of the effect produced by the detector's size on the resolution capacity of the measuring device for different dose distributions is given. An expression for the optimal choice of detector size is presented that takes account of the effect of the error due to the limited sensitivity. (auth)

23206 DISTRIBUTION OF DOSES PRODUCED IN WATER BY ELECTRONS AND POSITRONS WITH 5, 10, AND 15 MeV ENERGIES. Tarutin, I. G.; Kudin, V. I.; Gumanskii, G. A. (Research Inst. of Oncology and Medical Radiology, Moscow). Med. Radiol.; 15: No. 3, 78-80(Mar 1970). (In Russian).

Distribution of electrons and positrons (5, 10, and 15 MeV energies) with depth in water were measured using linear accelerator LNE-25. Graphic data presented indicated that positrons have a longer track in depth than the electrons; however, it was impossible to evaluate accurately the increase. Nevertheless, it was concluded that the theoretical ratio of positron and electron tracks were lower than observed and the depth distribution of the dose produced by positron radiation in water phantom did not differ so much from the identical curves of electrons as it was anticipated in the Takhar experimental work. (R.V.J.)

23207 PHANTOM MATERIAL FROM PARAFFIN AND POLYETHYLENE. Skoropad, Yu. D. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 15: No. 3, 71-5(Mar 1970). (In Russian).

The results are given of evaluation of the tissue-equivalent factor of phantom material consisting of 70% paraffin and 30% polyethylene. On the basis of calculations and experimental data, the possibility of using the proposed phantom material for the measurement of doses of quantum radiation with an effective energy ranging from 60 keV to 1.25 MeV with an error of ±10–15% is discussed. The technique of preparing the phantom material is described. (auth)

23208 AN EXPERIMENTAL INVESTIGATION OF THIMBLE IONIZATION CHAMBERS FOR ROENTGEN AND GAMMA-RADIATION. Archakov, A. A.; Vinokurova, Z. A.; Lapchuk, T. V. Med. Radiol.; 15: No. 3, 60-5(Mar 1970). (In Russian).

The results of experimental investigation of thimble ionization chambers (volume of 2 cm^3) prepared from different plastics are discussed. It was shown that the relation between the sensitivity of the chambers and the quality of radiation is determined both by the material from which the chamber (external electrode) is made and the material of the internal electrode. This permits a marked decrease in the energy dependence by special choice of the design. Similarly, individual dosimeters could be designed based on the redistribution of the charge on two condensers through the ionization volume, for a wide range of exposure doses, with a significant mechanical resistance and energy dependence error of 10%. Theoretical calculation of the characteristics of the chambers is very difficult, so the choice of elements of the detector can be made out on the basis of experimental data. (auth)

23209 MEASUREMENT OF THE LAYER OF HALF DOSE WEAKENING IN SHORT-DISTANCE X-RAY THERAPY. Akatin, O. A.; Pozdnyakov, G. E. (Krasnodar Regional Oncological Clinic, USSR). Med. Radiol.; 15: No. 3, 57-9(Mar 1970). (In Russian).

Measurements of the half-thickness for x radiation (Eff–15 to 25 keV) are given for the purpose of selection of universal regimes of irradiation of neoplastic diseases of the skin. The tissue equivalence of paraffin and wax was evaluated. The errors in measurement of the dose and half-thickness associated with the energy dependence of ionization chambers in phantom measurement are discussed. (auth)

23210 SEMI-EMPIRICAL METHOD OF CALCULATION OF INTEGRAL DOSES IN RADIOTHERAPY. Pospelova, I. I. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol.; 15: No. 3, 53-7(Mar 1970). (In Russian).

A semiempirical ratio is presented that was obtained on the basis of analysis of dose fields beyond the limits of the radiation beam created in tissue-equivalent phantom by γ radiation of cobalt apparatus Luch-1 and bremsstrahlung from linear accelerator with an energy of 4.3 MeV. The obtained ratio permits assessment of the integral dose in the studied region of irradiated objects of terminal dimensions with an error of 10%. (auth)

23211 THE EFFECT OF SPECTROPHOTOMETRY ERROR ON THE ACCURACY OF THE PERSPEX H.X. MEGARAD DOSEMETER. Crookall, J. O. (Inst. of Cancer Research, Sutton, Eng.); Marshall, C. H. Phys. Med. Biol.; 15: 319-24(Apr 1970).

An experimental interchange of irradiated Perspex H. X. samples between laboratories has been performed to test the effect of spectrophotometry errors on the accuracy of the system as a reference dosemeter for electrons and γ radiation in the megarad range. It has been concluded that if all optical density measurements are made relative to an unirradiated (control) sample the spectrophotometry errors are well within ±3%. (auth) (UK)

23212 USE OF FERROUS SULFATE FOR DOSIMETRY BY POST. Ahmed, S. A. (Western Regional Hospital Board, Glasgow); Law, J.; Walton, P. W. Phys. Med. Biol.; 15: 311-18 (Apr 1970).

Ferrous sulphate dosemeter solution in plastic irradiation vessels was posted to three radiotherapy centres for ^{60}Co irradiation, and taken to a fourth centre for 4 Mv x-ray irradiation, as an experimental trial for the future dosimetry of high energy electron therapy beams. The ferrous sulphate was returned for measurement, and doses calculated from the results have been compared with estimates based on ionization measurements with Farmer–Baldwin dosemeters calibrated at the National Physical Laboratory. $FeSO_4$ and ionization dose estimates have not differed by more than 2% at any centre, and the precision of a short series of measurements at a single centre is better than 1%. The irradiation vessels are non-breakable, cheap, and have been shown to have no adverse effect on solution response. (auth) (UK)

23213 RADIATION DOSES RECEIVED BY STAFF IN BRITISH HOSPITALS AND THEIR RELATION TO MAXIMUM PERMISSABLE DOSES. Langmead, Walter A.; Steadman, E. J. (British Inst. of Radiology, London). Brit. J. Radiol.; 43: 279-80(Apr 1970).

Individual dose records relating to different classes of medical workers are given. From these it is clear that radiation doses to the staff of at least some British hospitals can be reduced to negligible values. Other departments where the dosage level to staff is higher than shown here should review their methods of working and their protection arrangements. (UK)

Radiation Protection

Refer also to abstracts 23333 and 23385.

23214 (NP–18158) INTERNATIONAL DIRECTORY OF OCCUPATIONAL SAFETY AND HEALTH SERVICES AND INSTITUTIONS. Occupational Safety and Health Series No. 16. (International Labour Office, Geneva (Switzerland)). 1969. 520p. (In several languages). Dep. CFSTI (U. S. Sales Only). International Labour Office, Geneva Free.

Directory information is listed by the country in alphabetical order and by alphabetical order of the name of each service within a country. Under each service is included information on status, principal officers, departments or sections, functions, activities, and publications. A separate list of international organizations is provided also. Information is included on official services, such as the labor and medical inspectorates in each country. (C.O.)

23215 (NVO–294–3) ON-SITE RADIOLOGICAL SAFETY AND MEDICAL SERVICES. Project MILROW. (Eberline Instrument Corp., Santa Fe, N. Mex.). 20 Feb 1970. Contract AT(26-1)-294. 26p. Dep. CFSTI.

Radiological safety support included installation, calibration, and operation of remote area monitoring and air sampling systems, personnel dosimetry, environmental sampling, survey and monitoring activities and exclusion area control. All of the above activities indicated no release of radioactive materials to the environment. Medical coverage included treatment of occupational and non-occupational injuries and/or diseases of the island population, patient evacuations, surveillance of island food, water and sanitary services, and other activities based on AEC Manual Chapter 0528. The main medical facility was located at the Huskey Camp Area with an additional dispensary at the Northwest Camp. The total medical load from D – 60 to D + 30 was 1664 of which 346 were occupational and 1318 were non-occupational. Forty patients were referred off-site for additional treatment during this period. (auth)

23216 (RPS–AR–2) ANNUAL REPORT FOR THE YEAR 1968. (Ministry of Public Health, Bangkok (Thailand). Radiation Protection Service). 15p. Dep. CFSTI (U. S. Sales Only).

The Radiation Protection Service of Thailand was developed and trained in cooperation with New Zealand. Duties of the service consist in surveying about 600 x-ray machines for clinical use; the surveying of sealed radium sources for clinical use with a total activity of 3 Ci; and the monitoring of seven x-ray machines used for industrial purposes. Staff, equipment, film service, and present activities are described. Results of the activities are summarized in six tables. (H.B.G.)

23217 MONITORING OF PERSONNEL INVOLVED WITH INTRACAVITARY GYNECOLOGICAL RADIOTHERAPY. Toeroek, Istvan; Boros, Laszlo (Univ., Budapest). Strahlentherapie; 138: 677-84(Dec 1969). (In German).

The results of radioprotection measurements in gynecological curietherapy were reported. Conventional dosimeters, glass and thermoluminescent dosimeters were used. Fast working and distance are the best methods for protection. Eventually high doses are caused by disregarding the protection rules. (auth)

23218 PROBLEMS OF DOSIMETRY AND PROTECTION AROUND HIGH-ENERGY PROTON ACCELERATORS. Rindi, A. (CERN, Geneva). Minerva Fisiconucl., 12: 20-7(Jan.-Mar. 1968). (In Italian).

Radiation protection in the accelerator field poses new and difficult problems of dosimetry. The interaction of living tissues with new types of secondary particles, the wide range of energy of these and of conventional nucleons, the emergence of new radioisotopes of high energy pose problems quite different from those encountered with reactors and radioisotopes. The problem of direct measurement of the dose equivalent, not yet completely solved for low energies, is infinitely more difficult for mixed fields of very high energy. Extrapolation of biological concepts of biological action of relatively low radiation energy and neutron flux to fields so different in character and energy is not practicable. Security considerations may lead to excessive estimation of dose equivalents, but such procedures are scientifically unsatisfactory. To give an idea of the situation prevailing in an accelerator field of high energy, a bird's-eye view is given of the 600 MeV synchrocyclotron and the 28 GeV proton-synchrotron of CERN. When a particle of such high acceleration as is produced in these accelerators hits a target, numerous nuclear and subnuclear particles are produced; of the latter so far only 30 were identified. Only a small part (less than 10%) of the proton beam is channeled into the research apparatus. The rest remains in the accelerator and produces all kinds of secondary particles that constitute the radiation propagated toward the biological shield. Some particles decay almost instantly and are, therefore, of no health concern; others have a longer median life and may travel considerable distances. Protons and neutrons are produced in abundance. Pions are also abundant and, though they have a short life, their decay produces 67.5 MeV photons. The decay of the short-living p^+ gives rise to the long-living μ^+ which may travel long distances. Kaons have the same mean life as p, but their production requires energies of 200 GeV,and, therefore, will be of concern to future accelerator technicians. In addition to p, μ, π, and n particles, powerful γ-radiation must also be considered. It is extremely difficult to separate these particles and to evaluate their specific biological effect. However, from the viewpoint of health protection, the neutrons seem to be the most important components of radiation near a high energy accelerator. Numerous calculations are made (based primarily on the Monte-Carlo method) to arrive at a combined HVL and through it estimate the required thickness of shielding material for biological protection. The obtained necessary thickness of shielding material of some important accelerators is shown in a table. The CERN 600 MeV synchrocyclotron requires a concrete shield of 5.8 m thickness. The CERN 28 GeV proton-synchrotron has a 6 m thick shield of special concrete. For the prospective USA 200 GeV protonsynchrotron a concrete shield of 13.5 m is anticipated. Little progress was made in calculating and measuring the dose equivalent of the accelerator radiation. No instrument was yet devised which would allow a direct measurement of the dose equivalent. Ionization chambers calibrated according to empirical tissue damage are presently the best instruments that give a fairly good measure of absorbed dose. However, not many studies were made on their use in a high energy particle field. In addition, several other instruments are mentioned and it is necessary to combine the measurement results of several instruments. (F.J.W.)

23219 A MEANS OF REDUCING RADIATION EXPOSURE FROM TECHNETIUM GENERATOR OPERATIONS. Barnett, Huey D.; Harris, C. Craig (Duke Univ., Durham, N. C.). J. Nucl. Med.; 11: 180-1(Apr 1970).

Lead body shields and lead perchlorate-filled plastic face shields developed for the protection of personnel against γ radiation during the handling of the ^{99}Tc eluate from ^{99}Mo-^{99}Tc generator assemblies are described. (C.H.)

23220 MEDICAL SUPERVISION OF CERN PERSONNEL EXPOSED TO IONIZING RADIATIONS. Diss, J. P. Rev. Med. Suisse Romande; 88: 122-30(Feb 1968). (In French).

The medical supervision of personnel of the Organisation Européenne pour la Recherche Nucléaire (CERN) exposed to radiations emitted by particle accelerators conforms to generally accepted requirements and the recommendations of the various international organizations (ILO, WHO, ICRP). Certain aspects of this supervision, however, present uncertainties and even difficulties. This is especially the case with the interpretation of analyses of blood samples taken during routine examinations. The purpose of this study is to draw attention to certain particular points, especially the question of routine hematological examinations, their value, and usefulness. (Occup. Safety and Health Abstr.)

Safety Procedures

Refer also to abstracts 23143, 23146, 23363, 23386, and 24734.

23221 (AEC-tr-7132) THE STATE OF HEALTH AND CLINICAL PECULIARITIES OF REACTIONS TO OCCUPATIONAL IRRADIATION IN MEDICAL ROENTGENOLOGISTS. 756. HYGIENE AND OCCUPATIONAL DISEASES. Soldatova, V. A. (Akademii Meditsinskikh Nauk SSSR, Moscow. Institut Gigieny Truda i Professional'nykh Zabolevanii). Translated from a Russian report. 14p. Dep. CFSTI.

Radiation hazards to medical personnel working with x radiation are discussed. In experienced roentgenologists, the dose load is distributed unevenly with the main dosage having been received during their first years of work, while the radiation levels during the last 5 to 10 years are on the order of $\frac{1}{3}$ to $\frac{1}{2}$ of the maximum permissible dose. The clinical syndrome manifests itself in changes in the composition of peripheral blood, development of neurocirculatory dystonia, moderate inhibition of gastric secretion, and local skin reactions. Cessation of irradiation or lessening of its intensity leads to restorative processes that occur most noticeably in the hematopoietic system. The ending of contact with the injury causing factors and rational working arrangements are suggested as protective measures. (H.B.G.)

23222 (AEC-tr-7133) THE STATE OF THE OPTICAL ORGAN IN THE CASE OF CHRONIC EXTERNAL GAMMA-NEUTRON AND X-RAY IRRADIATION. 756. HYGIENE AND OCCUPATIONAL DISEASES. L'vovskaya, E. N. (Akademii Meditsinskikh Nauk SSSR, Moscow. Institut Gigieny Truda i Professional'nykh Zabolevanii). Translated from a Russian report. 14p. Dep. CFSTI.

Basic data were obtained that indicate a statistically reliable high frequency of age changes in groups of persons subjected to the action of ionizing radiation. The members of the groups showed some signs of accelerated aging of the crystalline lens and vessels of the eye. These signs were expressed in terms of intensification of optical induration, an increase in the intensity of coloration of the tissue of the lens, a greater frequency of senile cataracts, and a greater frequency of sclerotic-type changes of the retinal vessels in persons with maximum radiation doses (total exposure doses of 200 to 500 rem). The chronic action of external γ-neutron and x radiation in the range of doses studied did not cause the formation of a radiation cataract. Experimental investigations with animals confirmed the clinical observations. The members of the occupational groups, in addition to the symptoms of accelerated involution of the vessels of the eye and the lens, showed some differences from the control group with respect to the indexes of the hemodynamics of the eye. Two forms of the participation of the eye in the reaction to radiation are distinguished. The first group of changes consists of local injuries involving the more rapid involution of the lens and the development of specific changes (radiation cataracts). These changes correlate mildly with the total radiation and their development is determined by the achievement of certain threshold values of local doses of irradiation of the eye. The second group, which involves changes of the hemodynamics of the eye, encompasses part of the general manifestations of the reaction of the body to radiation effects. In these cases there is a correlation between the hemodynamic changes in the eye and the general clinical syndrome of circulatory shifts and especially the state of cerebral blood circulation. A series of practical recommendations are made on the basis of experimental evidence and published data. (C.O.)

23223 (AECL-3254) SUBMISSION TO THE SCIENCE SECRETARIAT OF CANADA RADIATION BIOLOGY TASK FORCE. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 16 Dec 1968. 84p. Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Research programs of the Division of Biology and Health Physics, Chalk River Nuclear Laboratories, Atomic Energy of Canada Limited are briefly summarized. The current status of selected programs is discussed. (C.H.)

23224 (SWRHL-82, pp 460-77) AEC CONTROLLED AREA SAFETY PROGRAM. Hendricks, Donald W. (Nevada Operations Office (AEC), Las Vegas).

The detonation of underground nuclear explosives and the subsequent data recovery efforts require a comprehensive pre- and post-detonation safety program for workers within the controlled area. The general personnel monitoring and environmental surveillance program at the Nevada Test Site are presented. Some of the more unusual health physics aspects involved in the operation of this program are also discussed. The application of experience gained at the Nevada Test Site is illustrated by description of the on-site operational and safety programs established for Project Gasbuggy. (auth)

23225 ON ASSESSING FATIGABILITY AND ATTENTION IN PERSONS EXPOSED TO SMALL DOSES OF IONIZING RADIATION IN THE COURSE OF THEIR WORK. Losev, A. A. Gig. Tr. Prof. Zabol., 11: 50-2(Aug. 1967). (In Russian).

A total of 318 people at the Joint Institute of Nuclear Studies in Dubna was selected for the tests. A total of 217 people worked with radiation, and 101 people had no contact with radiation. The test consisted in identifying two letters out of a total of 205 letters over a period of ten minutes. The number of errors was determined each minute, and was found to increase at the end of the ten-minute period. The results showed that small doses of radiation had no effect on the psychic tiredness of the two groups. However, it was found that the people who could be identified as being afflicted with a neurotic state made a larger number of errors than people who were identified as normal. The frequency and number of errors were the same in people with a neurotic state irrespective of which group they were in originally. (TTT)

23226 ASSESSMENT OF RADIATION DANGER IN THE OPERATION OF CATHODE RAY TUBES. Makarova, L. A.; Volkova, N. I. Gig. Tr. Prof. Zabol.; 13: 53-5(Feb 1969). (In Russian).

X radiation in the range of 10, 15, and 20 keV is produced in high-velocity electron tubes, and the radiation dose is measured from this source. Measurements show that oscillographs and television tubes save readings of less than 0.1 microroentgens/sec (the detection limit of the meter). One oscillograph with a voltage of 40 kv on the tube gave a slight reading. It is desirable that in this type of equipment the screen shielding the electrodes be made of metal equivalent to 1 mm of lead. Readings of 1 to 4 microroentgens/sec are obtained in the absence of the protective glass cover when tuning the equipment. The dose should be kept within 10 mr/week to operating personnel. (TTT)

23227 ACUTE RADIATION AFFECTION OF THE HANDS. Orlov, V. M.; Petushkov, V. N.; Sych, L. I. Med. Radiol.; 15: No. 1, 53-6(Jan 1970). (In Russian).

A detailed description is given of severe radiation lesion of the hands in a 49-year-old patient occurring as the result of failure to observe the rules of radiation safety resulting in direct contact of unprotected hands with ^{60}Co granules with an activity of 51 R equiv. The exposure dose of γ irradiation at the body surface at the level of the chest comprised 150 R, and on the region of the hands not less than 10,000 R. Dynamic clinico-physiological data are given as well as the results of pathomorphological investigation of amputated segments. (auth)

Civil Defense

23228 (ORNL-TM-2457) SYSTEMS ANALYSIS OF U.S. CIVIL DEFENSE VIA NATIONAL BLAST SHELTER SYSTEMS. Haaland, Carsten M. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 203p. Dep. CFSTI.

Theoretically feasible alternative national blast shelter systems, including deployment schemes, costs, and effectiveness against nuclear attacks were studied. Various feasible alternatives are described with a list of independent parameters of function and operation. The useful domain of the parameters are established by investigation of the range of feasibility and practicality. Various kinds of systems are then theoretically constructed within the boundaries established by the imposed limitations. These systems were investigated for cost, and for the number of fatalities resulting from various size nuclear attacks. The cost per survivor added was used as a measure of effectiveness. Investigations were performed analytically and by digital computer. (auth)

Legal Aspects

Refer also to abstracts 23141, 23149, 23150, and 23370.

23229 (SWRHL-82, pp 498-507) PHILOSOPHY BEHIND THE FEDERAL RADIATION COUNCIL GUIDES. Tompkins, Paul C. (Federal Radiation Council, Washington, D. C.).

Radiation Protection Guides for application to activities such as Plowshare would be derived on the basis of the philosophy of the FRC in making recommendations for the control of radioactivity associated with normal peacetime operations as given in FRC report 1. Considerations involve a balance of benefit versus risk for each Plowshare activity that is proposed for industrial application using potential exposures small in comparison to the basic guide of 0.17 rem per year as the primary reference condition. Alternate approaches to achieving an appropriate balance have been suggested. These include allocation of a fraction of the 0.17 rem per capita per year to each relevant activity; setting a universally applicable MPC for each nuclide of interest, and the concept of the dose commitment. Data to show the benefit in terms of the national need for the resource in question (e.g., gas production) and the risk as indicated by the amount of residual radioactivity are a prerequisite to setting guidance for using Plowshare techniques in conjunction with consumer products available to the general public. (auth)

23230 (SWRHL-82, pp 508-28) APPLICATION OF ICRP RECOMMENDATIONS RELEVANT TO INTERNAL DOSE. Cowser, K. E.; Snyder, W. S.; Struxness, E. G. (Oak Ridge National Lab., Tenn.).

Several of the basic concepts of radiation protection (with emphasis on internal dose) currently recommended by the International Commission on Radiological Protection (ICRP) are reviewed, the assumptions and methods used in the calculation of internal dose are summarized, and the practical application of the pertinent guidelines is illustrated. Two broad subject areas are considered: standards of radiation protection and bases of internal dose estimation. Topics discussed within the framework of radiation protection standards include maximum permissible dose, categories of radiation exposure, maximum permissible dose commitment, simultaneous internal and external exposure, multiple organ exposure, and size of the exposed group. Discussion of internal dose estimation is limited to selected items that include the body burden of radionuclides and the calculation of absorbed dose, the dose equivalent, the derivation of maximum permissible concentration (MPC), the relationship of stable element intake to the MPC, and short-term and chronic exposure situations. (auth)

23231 (SWRHL-82, pp 664-70) PLANNING REQUIRED IN THE DEVELOPMENT OF RADIATION PROTECTION GUIDANCE FOR UNDERGROUND ENGINEERING APPLICATIONS. Neill, Robert H. (Public Health Service, Rockville, Md.).

The potential variety of engineering applications from the peaceful uses of underground nuclear explosives indicates an increased need for applicable radiation protection guidance to protect the public health of potentially exposed populations. To ensure the orderly development of such uses, additional operational data as well as bioeffects data are required to develop appropriate criteria and guidance to inform health officials and the public of the significance of possible exposures. The required planning includes an evaluation of the potential benefits and risks as well as the size and age of population, multiplicity of sources, likely and unlikely future uses, and the total environmental impact. (auth)

23232 (SWRHL-82, pp 713-20) ROLE OF THE ATOMIC ENERGY COMMISSION. Oakley, W. L. (Atomic Energy Commission, Washington, D. C.).

Public health aspects of nuclear explosions fall into two categories: operational safety during the conduct of the explosion; and the regulation of by-product material resulting from the explosion. By statute, the AEC has the responsibility for both assuring operational safety and regulating by-product material. Current AEC safety and regulatory practices are described; future problems or needs discussed; and relation to federal, state, and local governments outlined. (auth)

23233 (SWRHL-82, pp 721-8) ROLE OF THE PUBLIC HEALTH SERVICE. Moore, Raymond T. (Bureau of Radiological Health, Rockville, Md.).

The Public Health Service must assume the role of the overall Public Health Coordinator, seeking to afford the highest level of health protection both to the nearby population as well as to the more distant groups. Data are given relative to the limited experience the PHS has had in the removal of populations from areas of suspected hazards. Problems inherent in the evacuation of civilians of all ages are also discussed. (auth)

23234 (SWRHL-82, pp 729-35) ROLE OF A STATE HEALTH DEPARTMENT IN AN UNDERGROUND NUCLEAR EXPERIMENT. Gerusky, Thomas M. (Pennsylvania Dept. of Health, Harrisburg).

When Project Ketch was first announced to Pennsylvania state officials, the Department of Health, under its legal responsibility to protect the health of the citizens of the state, was quick to realize that a thorough, independent review of the proposal was

necessary. Although the project was terminated by the sponsoring company before on-site preliminary evaluation work was begun, it is believed that the Department's approach was sound and practical. This study and the planned joint effort of the state and the Bureau of Radiological Health are discussed. (auth)

Medicine

Refer also to abstracts 22910, 23037, and 23038.

23235 (ACRH-32) SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION. Gottschalk, Alexander (ed.) (Argonne Cancer Research Hospital, Chicago, Ill.). Sep 1969. Contract AT(11-1)-69. 157p. Dep. CFSTI.

Four papers within the scope of NSA were abstracted previously. Eight additional papers discuss the characterization of proteins and reactions during immune response. A list is included of 50 publications during the period covered by this report. (C.H.)

Protective Substances

Refer also to abstracts 23273, 23302, 23401, 23404, 23405, and 23408.

23236 (NYO-2192-13) AN INVESTIGATION INTO THE PHARMACOLOGICAL PROPERTIES OF ANTI-IRRADIATION DRUGS. Progress Report. DiStefano, Victor (Rochester Univ., N. Y.). 27 Feb 1970. Contract AT(30-1)-2192. 23p. Dep. CFSTI.

The pharmacological effects of certain radioprotective compounds were studied in mice and cats in an effort to elucidate the mechanisms for their physiological actions. Data are included on AET, cystamine, and MEG. Two new compounds, sodium hydrogen 5-(2-aminoethyl) phosphorothionate (AEP) and 3-(2-mercaptoethyl-amino-propionamide p-toluene sulfonate (METS) were also tested for pharmacological effects on cats, and was dimethylsulfoxide (DMSO) used as a preservative for bone marrow cells for eventual transplantation into humans. (C.H.)

23237 GRAFT-VERSUS-HOST INHIBITION. III. FETAL THYMIC FACTOR AND FETAL LIVER CELLS TO MINIMIZE SECONDARY DISEASE. Bortin, Mortimer M.; Rimm, Alfred A. (Mount Sinai Hospital, Milwaukee. Marquette School of Medicine, Inc., Milwaukee). Transplantation; 9: 310-21(Mar 1970).

Lethally x irradiated CBA host mice were given iv injections of perinatal liver hematopoietic cells from strain A donors. Survival studies demonstrated that 57% of the hosts were alive at 100 days when treated with fetal liver cells, and 50% survived 100 days when treated with liver cells from five-day-old mice. All lethally irradiated CBA mice survived 100 days when protected with strain A fetal liver cells iv plus ip Millipore chambers containing thymus cell suspensions from strain A fetal donors. This salutary effect on survival, over that observed with liver cells alone, was highly significant ($P < 0.001$). This beneficial effect on survival was eliminated when the Millipore chambers containing fetal thymus tissue were first stored 8-10 days in temporary syngeneic hosts. The addition of thymus tissue in Millipore chambers from strain A five-day-old donors did not significantly alter survival from that observed when only liver cells were given. It was concluded that the strain A fetal liver-thymus combinations acted synergistically to enhance survival of the CBA mice. This effect was probably caused by a subcellular factor from the fetal thymus which acted on the liver cells. It was noteworthy that the subcellular factor was apparently present only in the fetal thymic tissue. Secondary disease was at a minimum as evidenced by the excellent long-term survival, healthy and vigorous appearance of the mice, absence of overt graft-versus-host disease, and absence of overt infection. (auth)

23238 JOINT LETHAL EFFECTS OF ACTINOMYCIN D AND RADIATION IN MICE. Smith, Willie W.; Carter, Stephen K.; Wilson, Shirley M.; Newman, Joseph W.; Cornfield, Jerome (National Cancer Inst., Bethesda, Md.). Cancer Res.; 30: 51-7(Jan 1970).

Results are reported from studies on mice on recovery from sublethal actinomycin D or γ radiation damage as measured by joint lethality of the two treatments separated by an interval of one hr to four days. In mice given actinomycin D and challenged with radiation, the high mortality attributable to joint treatment decreased steadily between the six-hr and the three-day challenge. On the other hand, in mice given radiation and challenged with actinomycin D six to 24 hr later, there was no evidence of recovery from the radiation damage, survival remaining at or below the 20% level seen when actinomycin D and radiation were given together. This is unlike the result obtained with a divided radiation dose, where survival was markedly increased when the second fraction was given three to six hr or 24 hr after the first. Thus, there exists a residual effect of radiation not uncovered by a second irradiation, but clearly demonstrated when the challenge is an injection of actinomycin D. Estimated parameters of the 28-day dose-survival curves for actinomycin D alone and radiation alone were essentially the same when a factor for rads/μg actinomycin D was supplied. When actinomycin D was given one hr before irradiation, dosewise additivity at the 50% response level was approximately 85%. Application of this factor gives dose-response curves for joint treatment with the same characteristics as those observed for mice given either treatment alone. For equal 28-day mortality, however, there was a significantly higher percentage of deaths six to nine days after treatment in the mice given actinomycin D than in mice given radiation alone. (auth)

23239 THERAPY OF LETHAL RADIATION INJURY WITH ACTIHAEMYL IN ANIMAL EXPERIMENTS. Barth, Gunther; Graebner, Herbert F.; Lotz, Henning (Univ., Giessen, Ger.). Strahlentherapie; 138: 714-23(Dec 1969). (In German).

The statistically significant efficiency of the drug Actihaemyl on the radiation mortality of 2,700 mice was demonstrated. A significant increase of survival, up to 44%, was obtained when it was administered 3 hours after a whole-body irradiation of 600 R. When the dehydration is measured by the hematocrit value, a rapid normalization was observed, when compared to control animals. A significant effect on the bone marrow was not observed, but the myeloblasts recover more rapidly and earlier. The curative effect of Actihaemyl was explained by a better oxygen metabolism of the tissue, whose oxygen supply is always reduced after irradiation. (auth)

23240 EFFECTS OF FOOD CONSERVATION SUBSTANCES ON THE SURVIVAL RATE OF RATS FOLLOWING WHOLE-BODY X RADIATION. Peters, Karl Wilhelm; Peters, R. (Univ., Tuebingen, Ger.). Strahlentherapie; 138: 724-32(Dec 1969). (In German).

Hexamethylene-tetramine in doses of 0.8 mg/ml, 0.08 mg/ml, and 0.02 mg/ml in water enhanced the mean survival of whole-body x-irradiated rats (700 to 920 R) the difference proved to be statistically significant. A treatment before or before and after radiation was more efficient than a treatment after radiation. Treatment with sodium-benzoate caused only a slight increase of the survival with doses of 0.36 mg/ml, 0.09 mg/ml, 0.08 mg/ml, 0.02 mg/ml, and 0.005 mg/ml. The effect of Nipagin (0.02 mg/ml) on whole-body x-irradiated rats with doses of 625 to 825 R was not clear. (auth)

23241 EFFECT ON THE RADIATION SYNDROME OF THE COMBINED ADMINISTRATION OF VITAMIN B 12 AND FOLIC ACID IN WHOLE BODY RADIATION IN RATS. Morczek, A.; Schmidt, W. (Medizinische Akademie, Magdeburg, Ger.). Folia Haematol. (Leipzig), 90: 401-10(1968). (In German).

The effect of vitamin B_{12} and folic acid on the radiosyndrome was tested in combined administration by means of the surviving rate of animals and the hematological changes in 192 whole-body, x-irradiated white rats in groups of 24 animals with doses of 600, 800, 1000, and 1200 R/O. X irradiation of 600 R significantly increased the survival rate. In the sublethal range of doses (600 R and 800 R) the active agents administered showed a stimulating effect on the repair of reticulocytes and erythrocytes. After lethal doses a diminished depression of reticulocytes, erythrocytes, thrombocytes, and leukocytes could be proved in the first two weeks post-irradiation; however, there was no stimulating effect of vitamin B_{12} and folic acid on recovery from the radiosyndrome. (auth)

Radiation Sickness and Injuries

23242 (LF-tr-40) CASE OF RADIOACTIVE CESIUM ISOTOPE INJURY. Kirillov, S. A.; Vissonov, Yu. V. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Med. Radiol.; 13: No. 12, 20-5(1968). 10p. Dep. CFSTI.

Clinical observations and therapeutic procedures are reported for a patient subjected to the impact of a solution of ^{134}Cs and ^{137}Cs during an accident in which drops of the solution fell on his face, body and clothing, resulting in an external radiation dose of one rad. Some of the solution possibly entered into the oral cavity. The most significant change observed was in blood leukocyte picture, with leukopenia developing on the 16th day and fluctuations up to the 91st to 95th day, when the count stabilized at a normal range. Changes in the cytology of bone marrow biopsy samples were also observed. Excretion of ^{134}Cs and ^{137}Cs in urine and

feces, diminishing in concentration, and results of whole-body counting confirmed that the isotopes had been ingested. The internal irradiation dose on the 95th day was established to be 130 rad. Changes in the blood, nervous system, liver function, and intestinal function observed in another patient who accidentally drank a solution of ^{137}Cs with an activity of 4 mCi, and changes observed in five individuals who ingested ^{137}Cs with an activity varying from 60.4 to 106 μCi of activity are also summarized. (C.H.)

23243 SUPPLEMENTAL TREATMENT OF RADIOGENIC ENTEROCOLITIS USING BACILLUS SUBTILIS. Graebner, H. F. (Univ., Giessen, Ger.). Med. Klin. (Munich); 64: 1080-4(Jun 1969). (In German).

As a result of radiotherapy for malignant tumors, 44 cases of enterocolitis were reported. Treatment consisted of Bactisubtil that was successful in arresting diarrhea 4 to 6 weeks earlier and in most cases even during radiotherapy. The Bactisubtil treatment was not affected by age, radiation dose, or the irradiated field. (tr-auth)

23244 THE THERAPEUTIC EFFICACY OF HIGH-POLYMER HETEROLOGOUS DNA IN DOGS WITH ACUTE RADIATION SICKNESS. Rogacheva, S. A.; Luzanova, O. V.; Klyzhuk, K. N.; Rusinova, G. G.; Sharova, E. G.; Libinzon, R. E. (Inst. of Biophysics, Moscow). Med. Radiol.; 15: No. 3, 44-9(Mar 1970). (In Russian).

In experiments on 52 dogs irradiated from a ^{37}Cs source (6 R/min) in doses of 700 and 750 R, the therapeutic effectiveness of high-polymer heterologous DNA of calf thymus was demonstrated. DNA preparations were obtained by the method of Kay, et al. The therapeutic effect of DNA (introduced intravenously in a dose of 15 mg/kg of body weight) depended upon the time interval between irradiation and injection of the preparation. The greatest survival (8 out of 11 dogs) was noted when the preparation was introduced 24 hours after irradiation. In DNA injection 3 days or 30 to 60 minutes after irradiation the survival was 6 out of 11 and 4 out of 12 animals respectively. In the control group 2 out of 18 dogs survived. The relation between the therapeutic effect and time of DNA injection after irradiation is discussed. (auth)

Radiodiagnosis

Refer also to abstracts 22613, 23003, 23006, 23199, and 23200.

23245 (BRH/DMRE-70-1) SURVEY OF THE USE OF RADIONUCLIDES IN MEDICINE. (Stanford Research Inst., Menlo Park, Calif.). Jan 1970. Contract PH 86-67-15. 132p. CFSTI.

The results of a study to determine the use of radionuclides in medicine in the United States are given. The number of different procedures performed during 1966 are based on responses to a questionnaire sent to 7,204 physicians. Detailed information on 23 procedures was obtained from a sample of 879 physicians in early 1969. (auth)

23246 SCINTIGRAPHY IN DIAGNOSTIC STUDIES OF ABDOMINAL ORGANS. Pabst, H. W.; Frey, K. W. Arch. Klin. Chir.; 322: 139-49(1968). (In German).

The advantages of using ^{99m}Tc for splenic and gastric scintigraphy were discussed. The most effective means of representing the spleen was by use of heat-treated erythrocytes labeled with ^{99m}Tc, that were selectively taken up by this organ. The irradiation exposure of the spleen when ^{99m}Tc was used was very low and permitted the size of and the defects caused by tumors, infarcts, or hemorrhages to be readily detected. With extensive parenchymal defects and loss of function of the spleen, the ^{99m}Tc appeared in the liver. The most extreme case observed was in splenic venous thrombosis, when the ^{99m}Tc-labeled erythrocytes were taken up by spleen very slowly and were found largely in the heart, aorta, and liver. With ^{99m}Tc the stomach and defects due to gastric carcinoma were readily demonstrated. However, x ray was superior to ^{99m}Tc for this. Intragastric injection of colloidal ^{99m}Tc was used to demonstrate lymph nodes located in the outflow area of the gastric lymphatic system and to indicate metastases in this area, but methodological difficulties prevented very extensive use of ^{99m}Tc for this purpose. (BBB)

23247 ISOTOPE SCANNING OF SPLEEN. Obara, Junnosuke; Toyama, Takao (Akita Central Hospital, Japan). Akita-Kenritsu Chuo Byoin Igaku Zasshi; 6: No. 1, 1-5(Mar 1969). (In Japanese).

Using ^{203}Hg-bromomercuri-2-hydroxypropane-labeled (MHP-203) erythrocytes, scintigraphy of the spleen was studied. Based on the results of 30 cases studied, the following indices were useful to determine spleen size: Surface area of the spleen in lateral view scintigrams (normal range in adult, within 70 cm^2); area ratio of spleen to surface of the body (normal range, within 4.5×10^{-2}). The count ratio of spleen to liver was occasionally useful to evaluate spleen function. Furthermore, the kidney scintigram that was suitable for differential diagnosis of the left upper abdominal mass, was also easily obtained by the above method. (NSA of Japan)

23248 IMPORTANCE OF MEASURING THE X-RAY SPECTRUM IN DIAGNOSTIC RADIOLOGY. Mika, Norbert; Reiss, Karl H. (Siemens AG, Erlangen, Ger.). Strahlentherapie; 138: 760-4(Dec 1969). (In German).

A method is described for the measurement of x-ray spectra from diagnostic apparatus with semiconductors. The advantage of this method in the easy handling of obtained data by electronic computers is outlined. Details are presented in six diagrams. (H.B.G.)

23249 COMPARATIVE AUTORADIOGRAPHIC AND QUANTITATIVE RADIOCHEMICAL STUDIES ON THE SAME MATERIAL. Lindner, J.; Freytag, G.; Grasedyck, K. (Univ., Hamburg). Acta Histochem., Suppl.; 8: 177-98(1968). (In German).

Two procedures for detecting radioisotope uptake by tissue were employed. In the first one, a part of the tissue was autoradiographically investigated by routine technique; the other part of the same tissue was wet-ashed and then counted. This method was employed with ^{35}S-labeled sulfates, tritium-labeled proline, and tritium-labeled thymidine to study inflammations, wound healing, connective tissue reactions in the neighborhood of malignant tumors, and arteriosclerotic processes in man and animals. The second procedure consisted of autoradiographic and radiochemical techniques performed on the same histological section or on serial sections from the same tissue block. Either the sections were first measured in a liquid scintillation counter and then autoradiographed or the autoradiogram was first obtained followed by measurement in the liquid scintillation counter. Advantages and disadvantages of the procedures were discussed, especially with respect to ^{35}S, tritium, and ^{14}C. (H.B.G.)

23250 CONCEPT OF THE HUMAN COUNTER: ITS APPARATUS, MEASUREMENT, AND CORRECTION. Linuma, T. Nippon Ishikai Zasshi; 59: 1165-8(1 May 1968). (In Japanese).

Human counters were used for routine and emergency measurements for radiation protection and for clinical purposes. The customary counting period is one hour; this length of time is often the lower limit for the evaluation of various factors. The counting geometry is a very important factor but no definitive method was agreed upon as yet. With an NaI crystal detector the arc, the standard chair, the multicrystal array, scanning, or their combinations were used; the 2π and 4π geometry was applied with organic scintillators. The geometry and the limits of detection were affected by the equipment used. The results exhibited the usual statistical and systematic errors; the former usually depended on the minimum counting time. Body absorption was responsible for some of the errors, especially at the low-energy range. Systematic errors were due to instability of the detector and the electronic circuitry, variations in the composition of the body, and in the distribution of radioisotopes. (TTT)

23251 FAILURE TO DETECT ^{131}I POSITIVE THYROID METASTASES WITH ^{99m}Tc. Meighan, J. W.; Dworkin, H. J. (National Naval Hospital, Bethesda, Md.). J. Nucl. Med.; 11: 173-4(Apr 1970).

A case of thyroid carcinoma metastatic to supraclavicular and mediastinal lymph nodes is presented. Both ^{131}I and $^{99m}TcO_4^-$ survey scans were done after thyroidectomy. The $^{99m}TcO_4^-$ scan failed to detect the ^{131}I positive mediastinal metastases apparently due to the high background counting rate in this area. (auth)

23252 ELECTROLYTIC COMPLEXATION OF ^{99m}Tc AT CONSTANT CURRENT: ITS APPLICATIONS IN NUCLEAR MEDICINE. Benjamin, Philip P.; Rejali, Abbas; Friedell, Hymer (Case Western Reserve Univ., Cleveland). J. Nucl. Med.; 11: 147-54(Apr 1970).

In an earlier report published elsewhere an electrolytic method of labeling human serum albumin with ^{99m}Tc at constant voltage was described, and possibilities for its clinical application were suggested. In the present paper these possibilities have been further explored. With constant-current electrolysis the quantity of the intermediate complexing agent dissolved at the anode was estimated with reasonable accuracy. Albumin may be used in any of the following forms after labeling: molecular solution, microaggregates, macroaggregates. Prolonged testing of these materials on animals produced no ill effects. A recipe for obtaining quantitative yields of the labeled albumin without the use of any anion exchange column is given. Representative scans of the various organs of the human body are presented. A plausible reaction mechanism is suggested. (auth)

23253 DIAGNOSTIC ACCURACY OF SOME PARAMETERS FOR EVALUATION OF ISOTOPIC NEPHROGRAM. Vianello, A.;

Busnardo, B. (Univ., Padua). Acta Isotop.; 9: 211-19(31 Dec 1968). (In Italian).

Sixteen parameters were applied to semiquantitative analysis of twenty normal radionephrograms in which ^{131}I-chlormerodrin was used as the tracer, in order to evaluate their statistical variability. Seven of these parameters and two others, proposed by us, all characterized by a slight dispersion of the data, were selected and applied to the study of the radionephrograms of twenty patients affected by idiopathic hypertension, who showed an apparently normal curve. The parameters with greatest diagnostic accuracy were those based on the measurement of the retention time of some particular segments of the curve during the excretory phase. (auth)

23254 BRAIN SCANNING: A COMPARISON BETWEEN TWO TRACERS, MAA-^{131}I AND NEOHYDRIN-^{203}Hg. Vianello, A.; Carteri, A.; Andrioli, G. C.; Ferlin, G. (Univ., Padua). Acta Isotop.; 9: 221-35(31 Dec 1968). (In Italian).

The results obtained in brain scanning with ^{131}I-MAA and ^{203}Hg-chlormerodrin in 10 normal subjects and in 63 patients with endocranial lesions are compared. The patients with endocranial lesions were: 27 cases of tumors; 32 patients with vascular lesions; one hydroma; and three subdural hematomas. In the normal subjects no false positive result was observed. In the 63 patients the two tracers yielded similar results as far as the recognition of endocranial lesions was concerned. Chloromerodrin labeled with ^{131}I seemed to be more accurate for as the delimitation of the size of the lesion. Both tracers showed a very limited usefulness for the diagnosis of the type of the lesion. (auth)

23255 HYPERTENSION AND HORSESHOE KIDNEY IN ONE FAMILY. Vianello, A.; Mastrogiacomo, I. (Univ., Padua). Acta Isotop.; 9: 247-52(31 Dec 1968). (In Italian).

Horseshoe kidney was recognized by ^{203}Hg-chlormerodrin scintiscanning in three brothers with hypertension. The inheritance of this condition is emphasized and the relation of the malformation to hypertension is discussed. (auth)

23256 AN ATTEMPT TO VISUALIZE A PHEOCHROMOCYTOMA BY MEANS OF ^{99m}Tc. Ferlin, G.; Mastrogiacomo, I.; Lazzarin, M. (Univ., Padua). Acta Isotop.; 9: 313-17(31 Dec 1968). (In Italian).

A satisfactory visualization of adenoma of the adrenal gland was obtained by means of the closed circuit TV reexamination of scintiphotographs obtained with the scintillation camera following the injection of 10 mCi of ^{99m}Tc-pertechnetate. (auth)

23257 PLACENTAL SCINTIGRAPHY WITH ^{113m}In. Galli, G.; Troncone, L. (Univ. Cattolica del Sacro Cuore, Milan). Med. Nucl.-Radiobiol. Lat.; 11: 361-76(1968). (In Italian).

Results of radioisotope placentography using ^{113m}In are discussed. This method permitted placental localization in nearly all cases, also in placenta praevia or posterior placenta, when its location by radiologic, thermographic, or ultrasonic methods was difficult. Radiation doses absorbed by the fetus and mother seemed to be low. (auth)

23258 MAMMARY SCINTIGRAPHY WITH MERCURY BICHLORIDE ($^{197}HgCl_2$). TECHNIQUE AND RESULTS. CORRELATIONS TO MAMMOGRAPHY. Canossi, G. C.; De Maria, D.; Romagnoli, R. (Univ., Modena, Italy). Med. Nucl.-Radiobiol. Lat.; 11: 341-59(1968). (In Italian).

The results of scintigraphic studies using ^{197}Hg-mercury bichloride in 44 patients suffering from mammary diseases of different kinds are reported. All these patients had previously had radiographic studies and afterwards histologic examinations were performed. Mammary scintigraphy was performed in the lateral projection 30 and 60 hours following mercury bichloride ($^{197}HgCl_2$) venous injection. A limited area of hyperfixation was indicative in case of a malignant disease when it persisted for 48 hours. Among 18 examined carcinomas 17 gave positive scintigraphic results with only one false negative (scirrhous carcinoma of small dimensions); among 26 cases of benign tumours and mastopathies, 25 presented negative scintigram, and only one false positive (fibrocystic mastopathy). Positive scintigraphy constantly corresponded to a sure radiographic report of malignant disease, and negative scintigraphy corresponded to a sure radiographic report of mastopathy. Sometimes correlation between scintigraphic reports and radiographic report classified as benign tumoral images, one of which gave positive scintigraphy (histologically: medullary carcinoma), and doubtful malignant tumor images was lacking: among 10 of these, seven were negative scintigraphically, and three positive (medullary carcinoma, post-mastopathy carcinoma, bilateral nodular metastases of palate carcinoma). It was concluded that scintigraphy using mercury bichloride shows a good indication as additional research whenever clinical and radiographic report do not solve doubts about the malignant or benign nature of mammary morbid process. (auth)

23259 CEREBRAL BLOOD FLOW EVALUATION USING ^{99m}Tc AND THE SCINTILLATION CAMERA. Casamassima, F.; Gainotti, G.; Senin, U.; Palumbo, R.; Signorini, E. (Univ., Perugia, Italy). Acta Isotop.; 9: 5-17(25 Dec 1968). (In Italian).

Scintiphotographic aspects of cerebral blood flow in man after rapid intravenous injection of ^{99m}Tc sodium pertechnetate were studied using the Anger γ camera. The procedure allows a qualitative evaluation of reduced or increased areas of blood perfusion and the identification of characteristic aspects of vascular or neoplastic cerebral diseases. (auth)

23260 NEOHYDRIN-^{203}Hg BRAIN SCANNING IN CEREBROVASCULAR DISEASE. Vianello, A.; Carteri, A.; Andrioli, C. (Univ., Padua). Acta Isotop.; 9: 19-30(25 Dec 1968). (In Italian).

The results of ^{203}Hg-Neohydrin brain scintiscanning in 70 patients having a diagnosis of cerebrovascular disease with acute (55 case) and gradual (15 case) onset are reported. Scanning was positive in 70% of the cases as compared with 26% for angiography. The greatest percentage of abnormal scans appeared between the third and the 50th day following the stroke. In no case did the examination become positive before the third and beyond the 60th day. These findings are useful in some cases for the diagnosis of cerebrovascular disease. (auth)

23261 SPLEEN SCINTIGRAPHY: EVALUATION OF RADIOACTIVE SCANNING METHODS WITH REGARD TO THE CLINICAL USES. Scandellari, C.; Ferlin, G.; Vianello, A. (Univ., Padua). Acta Isotop.; 9: 45-58(25 Dec 1968). (In Italian).

The various scintillation scanning techniques for spleen visualization are described and the usefulness of each method is evaluated with reference to different clinical indications. (auth)

23262 EXAMINATION OF THE SPINAL SUBARACHNOID SPACE WITH THE SCINTILLATION CAMERA. Senin, U.; Gainotti, G.; Casamassima, F.; Signorini, E.; Palumbo, R. (Univ., Perugia, Italy). Acta Isotop.; 9: 67-80(25 Dec 1968). (In Italian).

The usefulness of a scintillation γ camera for rectilinear scanning using ^{203}Hg-chlormerodrin in the exploration cerebrospinal fluid flow in the spinal subarachnoid space was investigated. A better definition of the scintiphotographic picture increases the diagnostic significance of same scintigraphic aspects, not clarified by traditional rectilinear scanning. (auth)

23263 THE USE OF RADIOISOTOPIC TECHNIQUES IN THE STUDY OF CONGENITAL RENAL POLYCYSTIC DISEASE. Vianello, A.; Ferlin, G.; Busnardo, B. (Univ., Padua). Acta Isotop.; 9: 81-95(25 Dec 1968). (In Italian).

A selected group of 10 patients with congenital renal polycystic disease was studied by means of renography, scintillation cameras, and scanning using ^{203}Hg-chlormerodrin. Renographic examinations revealed in all patients a delay in excretion which, in the more severe cases, was associated with marked impairment of secretion. In no instance was shape of the renograms thought to be characteristic of the disease. These renographic changes are discussed and their interpretation is based on recent anatomical studies of alterations produced by the abnormal development of the renal structures. Scintillation cameras make possible further systematic investigations and more detailed information on the physiopathology of renal polycystic disease. Scanning studies using ^{203}Hg-Neohydrin are useful only if the kidneys are still able to concentrate the radioactive substance. (auth)

23264 ^{87m}Sr IN THE SCINTIPHOTOGRAPHIC AND SCINTIGRAPHIC DETECTION OF BONE LESIONS. Ferlin, G.; Conte, N.; Vianello, A.; Melanotte, P. L. (Univ., Padua). Acta Isotop.; 9: 97-107(25 Dec 1968). (In Italian).

Results obtained in the visualization of bone lesions by the use of ^{87m}Sr are presented. The possibility of administering this tracer in high doses allows not only satisfactory scintigraphic images but also enables one to carry out studies using the Anger gamma camera. The time required by the procedure is therefore reduced and one is also able to secure a sequential evaluation of localized areas. The combined use of the gamma camera and of ^{87m}Sr allows a quick screening of bone diseases and is particularly useful in the detection of metastases. (auth)

23265 PELVIC ANGIO-SCINTIGRAPHY THROUGH ENDOARTERIAL INFUSION OF MAA-^{131}I IN SPREAD AND RECURRENCE DIAGNOSIS OF FEMALE GENITAL CANCERS. Onnis, A.; Varagnolo, C.; Maraiietti, G. C.; Gasparini, G. (Univ., Padua). Acta Isotop.; 9: 117-26(31 Dec 1968). (In Italian).

Endoarterial infusion of ^{131}I-MMA was found to be particularly fit for the scintigraphic evaluation of pelvic neoplastic focuses of gynecological neoplasms, both primary and secondary. The findings obtained with such a method and those obtained with angiography

are compared. Scintigraphic angiography often allows a better evaluation of neoplastic spread. (auth)

23266 DIAGNOSTIC VALUE OF RADIOISOTOPE INVESTIGATION OF IN VIVO THYROXINE METABOLISM IN THYROTOXICOSIS. Kotlyarov, E. V.; Nechaenko, M. A.; Sukhotskii, S. S. (Moscow School of Medicine). Med. Radiol.; 15: No. 1, 36-9(Jan 1970). (In Russian).

An investigation of radioiodine-thyroxine metabolism was made in 9 cases of euthyrosis and 11 cases of thyrotoxicosis of mild and moderate severity with the aid of a monomonitor system for whole-body radiometry. No significant differences were found in the value of the biological semiexcretion of radioiodine-thyroxine from the organism of either group of patients. The diagnostic value of studying the thyroxine metabolism may be evaluated only upon condition of parallel quantitative determination of the volume and concentration of stable thyroxine in the body and the rate of discharge from the organism. (auth)

23267 PRELIMINARY STUDY IN THE USE OF RADIOSTRONTIUM IN THE METASTATIC BONE LESIONS. Roncari, G.; Colombo, L. (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; 11: 377-98(1968). (In Italian).

A study of the kinetics of intravenously administered ^{85}Sr was made in patients with metastatic bone lesions in order to chose between ^{85}Sr and ^{87m}Sr and to investigate the technique of bone scanning. Six patients were included in this study and the results of serial serum and external point-count measurements and excretion data are reported. Also in 15 patients with confirmed or suspected bone metastases, bone scanning with ^{85}Sr and ^{87m}Sr was carried out in order to make a comparison of the results obtained with the two radionuclides. In five patients with confirmed bone metastases serial bone scanning was carried out in order to investigate the optimum scanning time. (auth)

23268 ^{51}Cr EDTA USE FOR THE GLOMERULAR FILTRATION RATE EVALUATION. Mombelli, L.; Fidanza, M. A. (Univ., Milan). Med. Nucl.-Radiobiol. Lat.; 11: 445-53(1968). (In Italian).

A disagreement in the literature concerning the value of ^{51}Cr-EDTA scanning of the kidneys for glomerular filtration rate evaluation is discussed. A comparison was made between clearance of this substance and clearance of the inulin determined by the continuous infusion method. The results are not completely positive for it is not shown that there is a significative difference between the average of the two clearance methods but a broad dispersion of the data was observed. This dispersion may cause an error in the evaluation of the glomerular filtration rate when this is measured from the ^{51}Cr-EDTA clearance data. (auth)

23269 BONE SCAN WITH ^{85}Sr IN SKELETON METASTATICAL LESIONS. Musumeci, S.; Loreto, C.; Cotroneo, G.; Tafuri, G. (Univ., Catania, Italy). Med. Nucl.-Radiobiol. Lat.; 11: 431-43(1968). (In Italian).

Results are reported on 54 neoplastic patients studied with bone scans with ^{85}Sr. This method gave better results than skeleton radiologic study in early demonstration of methastatic bone lesions and in localizations of the spinal column and of the sternum. The principal indications and limits of bone scan are considered, with a particular reference to the advantages offered by results of this method in the evaluation of therapy and of prognosis of neoplasms. (auth)

23270 VALUE AND LIMITS OF SCINTIGRAPHY WITH ^{85}Sr IN THE DIAGNOSIS OF SOME OSTEOPATHIES. Canossi, G. C.; De Maria, D.; Lenti, R. (Univ., Modena, Italy). Med. Nucl.-Radiobiol. Lat.; 11: 399-429(1968). (In Italian).

Results are reviewed that were obtained during one year's application of scintigraphy with ^{85}Sr in various skeletal diseases that illustrate working methods, the principles of bone physiopathology upon which the interpretation of the scintigrams is based, plus normal and pathological findings. The common denominator conditioning the positivity of the scintigram is attributed to the presence of an osteoblastic activity which may represent a primitive bone-forming process, but is more often an osteogenic reaction to a destructive process. Examples of the accumulation of ^{85}Sr in fracture sites in various phases of repair evolution, in Paget's disease, in primitive tumors (angioblastic sarcoma, reticolosarcoma, Hodgkin's lymphogranuloma, myeloma) and bone metastases (osteolitic and osteoplastic) are reported. Attention is called to causes of error owing to findings falsely positive (physiological hyperactivity of the metaepiphisary regions, parasitic radioactivity of feces and urine, etc.) and to findings falsely negative (small dimensions of the lesion, osteolysis without osteoblastic reaction, etc.). The principal advantage of scintigraph ^{85}Sr is the possibility of an earlier diagnosis than with radiology, especially in cases of metastases, the remarkable sensitivity of radioisotope technique in revealing reactive osteoblastic processes at the beginning of osteolysis. The information obtained by bone scintigraphy is complementary to that obtained by radiological examination. (auth)

23271 THE PRODUCTION OF ^{117}Sb-LABELLED POTASSIUM ANTIMONYL TARTRATE FOR MEDICAL USE. Thakur, M. L.; Clarke, J. C.; Silvester, D. J. (Hammersmith Hospital, London). Int. J. Appl. Radiat. Isotop.; 21: 33-6(Jan 1970).

Following a suggestion that potassium antimonyl tartrate (PAT) labelled with ^{117}Sb might be a useful agent for liver scanning, samples were produced by bombardment of natural indium foil in the external α-particle beam of a cyclotron followed by dissolution of the indium target, the recovery of the radioantimony and the preparation of labelled PAT for clinical injection. A 30 min bombardment of a 400 mg foil yielded about 35 mCi of ^{117}Sb. The process took less than one half-life to perform and loss of radioantimony was such that 30 per cent of end of bombardment activity was available in the final PAT solution. (UK)

23272 RADIOEPHROGRAPHIC CHANGES DURING ARFONAD-INDUCED HYPOTENSION IN DOG. Benedetti-Valentini, F. Jr.; Semprebene, L.; Fiorani, P.; Pistolese, G. R.; Citone, G.; Tomiselli, G. (Univ., Rome). Acta Isotop.; 9: 31-44 (25 Dec 1968). (In Italian).

Normotensive and hypertensive dogs were studied by means of ^{203}Hg-chlormerodrin kidney scanning under basic conditions and during vasodilatation induced with Arfonad. Administration of the drug proved to increase the diagnostic reliability of radionephrography and to give adequate informations about the anatomic and functional conditions of the kidney. (auth)

Radiotherapy

Refer also to abstracts 23100, 23125, 23209, 23210, 23217, and 23386–23391.

23273 A POSSIBILITY FOR THE FAVORABLE INFLUENCING OF CONVALESCENCE FOLLOWING GYNECOLOGIC RADIOTHERAPY. Picha, E. (Univ., Vienna). Med. Klin. (Munich); 63: 1191-4(26 Jul 1968). (In German).

The effects of a combination supportive treatment ot patients that had undergone irradiation for gynecologic tumors were discussed. The treatment consisted of oral administration of a mixture of an androgenic compound with several vitamins and amino acids. It was given for periods of up to 3 months. Out of 120 irradiated patients, 7 showed symptoms of irradiation injuries such as irradiation proctitis or cystitis. Wt losses ranged up to 8 Kg, but normal wt was regained by the end of 3 months by 100 of the patients placed on the androgen-vitamin supplement. Erythrocyte counts in the irradiated patients approached normal values in most cases more slowly than the body wt, but were favorably affected by the supplementary treatment. Leukocyte counts increased from below normal more slowly than the erythrocyte counts. The patients reported favorable improvement in subjective symptoms from the irradiation treatments. (BBB)

23274 MALIGNANT DEGENERATION OF IRRADIATED JUVENILE LARYNGEAL PAPILLOMAS. Maier, I. (Univ., Halle-Wittenberg, Ger.). Z. Laryngol., Rhinol., Otol.; 47: 862-8(Nov 1968). (In German).

Development of squamous cell carcinomas in two 23-yr-old patients that had been treated 13 and 19 yr previously with doses of 6600 and 4000 R of x rays for juvenile laryngeal papillomas was reported. The tumors developed in the areas previously irradiated. The patient that received the higher irradiation dose first developed carcinoma. Laryngeal carcinomas have been reported after irradiations with doses of up to 15,000 R. Thyroid carcinomas developed in 6 out of 43 children irradiated for laryngeal papillomas. It was concluded that, although carcinomatous degeneration of juvenile papilloma was a rare event, nowadays irradiation treatment of juvenile papilloma could no longer be justified. Irradiation treatment is no better than any other kind of treatment and may cause laryngeal stenosis, thyroid carcinoma, and laryngeal carcinoma. (BBB)

23275 STATISTICAL STUDY OF THERAPEUTIC IRRADIATION AND LEUKEMOGENESIS IN MAN. Kitabatake, Takashi (Niigata Univ., Japan). Nippon Ketsueki Gakkai Zasshi; 43: 805-9(Oct 1968). (In Japanese).

Statistical considerations were made of the relation between therapeutic irradiation and late development of leukemia on the basis of a retrospective survey, case study, and literature survey. For the retrospective survey, 1197 cases of leukemia and 2609 controls were collected from large hospitals in Japan from 1961 to 1965. Of these persons, 5.6% of 68 cases of leukemias and 6.10% or 159 controls had a history of prior medical irradiation (x-ray fluoroscopy or radiotherapy). Irradiation was a little

more frequent in controls than in leukemia cases, but not significantly so. However, the therapeutic irradiation incidence was appreciably higher in leukemia than control subjects, with a statistically significant difference. In the leukemia group the average frequency of fluoroscopy and the bone marrow dose from medical irradiation were significantly higher than in controls. In the case study there were 10 cases of leukemia that developed after therapeutic irradiation postoperatively for breast cancer from 1953 to 1965. The population at risk for these subjects during this period was 118,000 man-yr, as obtained from other published data. The maximum expected number of leukemia cases in 118,000 man-yr was calculated to be 8. The difference between the observed and expected values was statistically significant at the 1% level. In the literature survey, 49 cases of leukemia that developed after therapeutic irradiation for various diseases, as reported in Japan, were considered. The age distribution of these cases was appreciably different from that for general leukemia cases in Japan. However, the distribution of types was nearly the same as for general leukemias. The latent period showed a log-normal distribution, as seen in radio-induced cancer other than leukemia. There was a slight tendency of the larger radiation dose being associated with the shorter latent period. There was no correlation between the age at irradiation and length of the latent period. (BBB)

23276 ELECTRON THERAPY WITH 6 MeV LINEAR ACCELERATOR. Shigematsu, Yasushi; Hayami, Akimune (Osaka Univ.). Strahlentherapie; 138: 645-50(Dec 1969).

Technical improvements in the electron therapy with 6 MeV linear accelerators are reported. Dose rate reduction, monitoring system of dose and symmetry, and output measurements are discussed. Indications for electron treatment of relatively low energy range are also discussed. (auth)

23277 RADIOTHERAPY OF NON-NEOPLASTIC DISEASES. Lagunowa, Irina (Staatliche Zentralinstitut fuer Roentgenologie, Moscow). Strahlentherapie; 138: 660-1(Dec 1969). (In German).

Radiotherapy of non-malignant diseases should be restricted and should not be applied to children. In certain cases, however, low doses of soft x radiation are still a valid form of treatment. As examples, several acute and chronic inflammatory processes are discussed. (H.B.G.)

23278 RADIOBIOLOGICAL TREATMENT PLANNING IN RADIOTHERAPY. Spring, Erik; Malmio, Kai (University Central Hospital, Helsinki). Strahlentherapie; 138: 662-9(Dec 1969).

Radiotherapeutic treatment plans are currently based upon ionization measurements. Radiobiological treatment plans, based upon theoretical models that describe the interactions between radiation and cells are calculated. Comparisons are drawn between physical and radiobiological treatment plans, and also between the results obtained from different theoretical models. (auth)

23279 EFFECT OF IRRADIATION ON THE ELECTRICAL IMPEDANCE OF BRAIN TUMOURS. Laitinen, Lauri V.; Johansson, Gunnar G.; Malmio, Kai (University Central Hospital, Helsinki). Strahlentherapie; 138: 670-6(Dec 1969).

Steel wire electrodes were implanted into inoperable brain tumors and the surrounding brain tissue of seven patients. Irradiation treatment of the patients was started about two weeks after implantation. Before and during the course of the irradiation, lasting from 2 to 65 days, the electrical tissue impedance was measured twice a week through the implanted electrodes. The impedance magnitude during the whole implantation time showed wide variations from one recording day to the next. The irradiation had no appreciable effect on it. The heart-synchronous pulsatile component, ranging from 0.1 to 3% of the total impedance magnitude in the tumors, was also studied. During the irradiation time the daily variations, and likewise the pulse amplitude, decreased. The impedance changes are concluded to result from a decreased pulsatile blood flow. This assumption is in agreement with the radiation histopathology of small blood vessels. (auth)

23280 CLINICAL AND STATISTICAL ANALYSIS OF 371 RADIOLOGICALLY TREATED CASES OF CANCER OF THE ORAL FLOOR (1928-1963). Banfi, A.; Coopmans de Yoldi, G.; Mascheroni, F.; Milani, F. (Univ., Milan). Radiol. Med.; 55: 1208-20(Dec 1969). (In Italian).

Three-hundred and seventy-one cases of cancer of the floor of the mouth subjected to radiation therapy are described in terms of their clinical picture and of the treatment employed, radium x therapy in 81.7% and external x irradiation in 18.3%. Survival curves and percent values are presented. An overall five year survival of 28.6% was observed, with values of 49.3% in cases without adenopathy and 15.4% in cases with metastases. (auth)

23281 COMPLICATIONS OF RADIOTHERAPY FOR CARCINOMA OF THE BLADDER. Ram, M. D. (Royal Postgraduate Medical School, London). Proc. Roy. Soc. Med.; 63: 93-5(Jan 1970).

Sixty-five patients treated for carcinoma of the bladder with 4,000 to 6,000 rad total doses of electrons were examined over a minimum time of 18 months for late complications of radiotherapy. Sixteen complications were observed in 13 patients, including hemorrhagic cystitis, contracted bladder, intestinal strictures, intestinal perforation, vesicocolic fistula, and edema of the lower limbs and genitalia. Surgery was used for the management of most of these complications. It is stressed that surgery should be undertaken with caution as healing of irradiated tissues is poor and the rate of mortality and morbidity is high. (C.H.)

23282 RESULTS OF COMBINED RADIUM TREATMENT OF PATIENTS SUFFERING FROM CANCER OF THE UTERINE CERVIX WITH THE USE OF LINEAR ACCELERATOR. Gabelov, A. A.; Strutsovskaya, S. V.; Stukova, L. M. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol.; 15: No. 3, 3-5(Mar 1970). (In Russian).

Combined radiotherapy using bremsstrahlung linear accelerator (with an energy of 4.3 MeV) and intracavity. Curietherapy was effected in 140 patients suffering from cancer of the uterine cervix (27 persons with the first stage, 85 with the second, and 28 with the third stage of the disease). During a course of Curietherapy in the region of the primary neoplastic focus (uterine cervix) there were 3 doses averaging 6500 to 7000 rad and in the parametrial regions doses of 1000 to 1500 rad. Irradiation of patients from an external source between sessions of Curietherapy was carried out from two contralateral fields (anterior—suprapubic and posterior—sacrogluteal), the choice of the area was associated with the size of the minor pelvis. Irradiation was carried out daily from one field in a dose of 300 rad (150 rad/min). For weakening the intensity of irradiation in the region of the primary neoplastic focus created by the linear accelerator, special beams of radiation were employed with filters reducing the dose by 20 to 25% in respect to the dose received in lateral non-screened regions of the beam. During the employment of this technique of combined radium therapy in the perineal regions of the minor pelvis at the level of parametrial tissue the total dose amounted to 4500 to 5500 rad, with doses in the region of the primary neoplastic focus not exceeding 7000 to 8000 rad. The immediate results of treatment testify to the efficacy of radiation from linear accelerator. (auth)

23283 CYTOLOGIC STUDY OF RADIATION CHANGES IN CARCINOMA OF THE ORAL CAVITY; PROGNOSTIC VALUE OF VARIOUS OBSERVATIONS. Memon, M. H.; Jafarey, N. A. (Jinnah Postgraduate Medical Centre, Karachi, Pakistan). Acta Cytol.; 14: 22-4(1970).

Smears from 22 cases of oral carcinoma were examined before, during, and after radiation treatment (4,000 to 5,000 R γ delivered in fractionated doses of 200 R daily) for evaluation of radiation response according to the method described for carcinoma of the cervix uteri. The radiation response was calculated as the percentage of benign epithelial cells showing radiation changes, and correlated with the clinical status one year after start of treatment. No correlation was found between radiation response and clinical outcome, or the presence of malignant cells at the end of the treatment. A correlation was found between the size of tumor before treatment and the clinical result. (auth)

23284 INTERNATIONAL SYMPOSIUM ON EXTRACORPOREAL IRRADIATION OF THE BLOOD, REHOVOTH, ISRAEL, MARCH 17-19, 1969. Brit. J. Haematol.; 17: 405-15(1969). (CONF-690332-(Absts.)).

Eighteen abstracts from papers presented are given. These include 6 on the treatment of leukemia, 8 on cell kinetics, and 4 on immunosuppression. In addition, a summary of the conference is provided. (C.O.)

23285 ASSOCIATION OF METHOTREXATE TO TELECOBALT THERAPY IN MALIGNANT EPITHELIAL TUMORS OF THE UPPER DIGESTIVE TRACT. Cardinali, P.; Savino, G.; Sorrentino, R. (Ospedale Maggiore, Novara, Italy). Med. Nucl.-Radiobiol. Lat.; 11: 505-16(1968). (In Italian).

Results are reported in a group of patients with malignant epithelial tumors of the upper digestive tract treated with combined telecobalt γ therapy and methotrexate. Statistical analysis of the results for cases treated by the antimitotic drug compared with others equal to these for stage and location of the neoplasm treated with telecobalt γ therapy only showed results slightly more favorable, which, however, did not reach levels of statistical significance. (auth)

23286 RARE LOCALIZATION OF A THYROID CANCER METASTASIS. Soumar, J.; Haisova, L.; Hanek, P. (Charles

Univ., Prague). Oral Surg., Oral Med., Oral Pathol.; 29: 513-17(Apr 1970).

The case history is reported for a solitary metastasis of a thyroid gland adenoma to the mandible. The justification of the application of ^{131}I therapy is explained, and the accumulation of ^{131}I in the metastasis following the activation of the hypophysothyroid axis is discussed. The pretreated metastasis took over the primitive hormonal function of the thyroid gland. (auth)

23287 RADIOTHERAPY OF HEAD AND NECK CANCER. Umegaki, Yoichiro (National Cancer Center, Tokyo). Gan No Rinsho, Suppl.; 125-30(Nov 1969). (In Japanese).

The clinical data on radiotherapy of cancer of the head and neck treated at the Center are reviewed. Five-year survival rate as of May 1969 is 61.0% in contrast to 27.2% in 1957; the improved effectiveness was observed in cancer of the nasopharynx, oropharynx, tongue, oral cavity and throat, while no noticeable improvement in malignant lymphoma of the pharynx was found. Distant metastasis was not generally well controlled compared to the marked improvement in the efficacy of local treatment. The major therapeutic techniques consisted of radium and telecobalt irradiation; however, linear accelerator and betatron have been in more use due to simplicity and less radiation injury. The use of hyperbaric oxygenation and local radiation-sensitizing agents for the improvement of the effectiveness of radiotherapy proved to be most effective in cancer of the upper maxilla. Five patients given combined treatment of intra-arterial injection of 5-fluorouracil and irradiation with 5,000 to 6,000 R under hyperbaric oxygenation had a survival rate of 80.0% (period ranging from 2 years 10 months to 3 years and 4 months). Preservation of the function of an organ is an important factor in the treatment of cancer of the head and neck. In pharyngeal cancer, especially radiotherapy with linear telecobalt or partial surgical treatment has been replacing total pharyngectomy for improved prognosis. (NSA of Japan)

23288 POSTOPERATIVE IRRADIATION IN BRONCHOGENIC CARCINOMA. Kanno, Iwao; Ito, Yasuhiko (Tohoku Univ., Sendai). Kosankinbyo Kenkyu Zasshi; 20: 221-9(Sep 1968). (In Japanese).

Eleven patients were followed who were irradiated with ^{60}Co after surgery for bronchogenic carcinoma. The following results were obtained. The relation between the survival time since the beginning of the irradiation and the ^{60}Co dose: 3 of 4 cases irradiated with more than 10,000 R lived for more than 8 months, and 2 cases are still alive. Six cases of less than 6,000 R lived for less than 8 months. Especially in 4 cases of less than 3,000 R, all died within a half-year. The relation between the survival time after the operation and the ^{60}Co dose: 7 of 11 cases survived for more than 1 year and the other 4 cases died within 8 months. Less than 6,000 R of ^{60}Co was given to those 4 cases. One case has been alive more than 7 years; 3 cases that have survived for more than 4 years were irradiated more than 10,000 R. The periods from the operation to the beginning of the irradiation were more than 6 months for 5 cases and less than 6 months for 6 cases. (NSA of Japan) (TSS)

23289 RADIOTHERAPY OF MALIGNANT TUMORS IN INFANTS. WITH SPECIAL REFERENCE TO THE RADIOSENSITIZING ACTION OF ACTINOMYCIN D. Egawa, Jun (Tokyo Univ.). Gan No Rinsho, Suppl.; 137-43(Nov 1969). (In Japanese).

The significance of the use of Actinomycin D (Act D) in radiotherapy of Wilms' tumor in infants is discussed on the basis of review of the literature. Neuroblastoma is relatively sensitive to radiation and can be locally controlled by irradiation with 2,000 to 4,000 R delivered following surgical removal of tumors. However, high incidence of remote metastasis results in the rather poor prognosis. Actinomycin D, isolated from Streptomyces paravallus, proved to increase radiosensitivity when administered 30 minutes prior to irradiation, improving the therapeutic effectiveness with reduced metastasis. The standard dosage of Actinomycin D recommended by the Actinomycin D Study Group is to administer a daily dose of 10 μg/kg for 8 days, or 15 μg/kg daily for 5 days depending upon the systemic condition of the patient. Another course can be repeated after side effects disappear. Relative effectiveness in normal and tumor tissues, and the systemic effects of Actinomycin D are also discussed. (NSA of Japan)

23290 RADIOTHERAPY OF BRAIN TUMORS. Watari, Tsutomu (Tokyo Univ.). Gan No Rinsho, Suppl.; 131-6(Nov 1969). (In Japanese).

The basic rules for radiotherapy of brain tumors are studied on the basis of recent clinical experiences. Surgical treatment combined with irradiation was considered to be fundamental to all types of tumors. It is indicated that radiotherapy be extended to all nonneoplastic tumors of the brain. Better therapeutic results are expected for complete irradiation with more than 4,000 R. Reconsideration of the tolerance dose of the normal brain is desired; it is considered to be larger than expected. Of particular importance is completion of therapy with the initial treatment. In case of recurrence, craniotomy is prerequisite to another irradiation. BAR therapy (BudR, Antimetabolite, and Radiation) is suggested for more extensive application to tumors of the vertebral artery region provided the period of administration of antimetabolites is extended. Potential application for the treatment of glioblastoma multiforme and pons in which prognosis is generally unfavorable. Reconsideration of the therapeutic method for acromegaly is suggested since the index of growth hormone is not expected to be reliable. (NSA of Japan)

23291 RADIOTHERAPY OF LUNG CANCER. Kaneda, Hiromu; Kikkawa, Sumihiro (Kyoto Prefectural Medical School). Gan No Rinsho, Suppl.; 144-8(Nov 1969). (In Japanese).

Despite the progress in therapeutic equipment and methods, effectiveness of radiotherapy in lung cancer has not been improved from a rather low survival rate of approximately 5.0%. Reasons are that patients are usually in highly advanced stages for which surgical treatment is impossible, that the incidence of metastasis (especially in the brain) is high, and that tumor lethal dose has to be high, resulting in considerable disturbance to the lung. The effectiveness of radiotherapy depends first on how advanced tumors are in the initial stage of treatment. In addition, site of tumors, histological types, age, and blood pictures of patients are other factors influencing the effectiveness. The survival rate increases in parallel with age up to 6 years old and lowers thereafter as age advances. Remarkably poor prognosis of cancer in the left lung is possibly due to the high rate of metastasis and the influence of myocardial disorders. Tumors of undifferentiated type, especially oat cell carcinoma, prove to be most sensitive to radiotherapy, in contrast to adenocarcinoma. The degree of malignancy and the systemic condition of the patients are also critical in the effectiveness of irradiation; radiotherapy is contraindicated in cachexia and advanced anemia also decreases the effectiveness. Major side effects include disorders to the lung and heart, myelitis, and esophagitis. (NSA of Japan)

23292 DIAGNOSTIC VALUE OF THE ^{131}I UPTAKE TEST PERFORMED AFTER THERAPEUTIC TREATMENT WITH RADIOACTIVE IODINE. Spinelli-Ressi, F.; Banfi, F. (Ospedale Maggiore, Milan). Med. Nucl.-Radiobiol. Lat.; 11: 487-92 (1968). (In Italian).

The results are reported of a study on 94 patients treated for hyperthyroidism to ascertain the diagnostic significance of the ^{131}I uptake test performed at least four months after the administration of a therapeutic dose of ^{131}I. For the analysis of the results the patients were divided into three groups, depending on the time elapsed between administration of the therapeutic dose of ^{131}I and the execution of the test. The results of the uptake test were in disagreement with the clinical picture in nine cases out of 98, i.e., in 9.1% of the cases. Therefore, the experiment has, demonstrated that the uptake test is, in the majority of cases, valid as a test of thyroid function following therapeutic treatment with ^{131}I. (auth)

23293 RADIOTHERAPY OF BREAST CANCER. Igari, Sadanori (Federation of Public Service Personnel Mutual Aid Association, Tokyo). Gan No Rinsho, Suppl.; 154-9(Nov 1969). (In Japanese).

Unlike other adenocarcinomas, breast cancer is generally highly sensitive to radiation. It is accordingly difficult to choose the right kind of treatment; single surgical treatment or single radiotherapy, combined use of the two, or addition of chemotherapy. There is also a considerable discrepancy among the specialists as to the method of surgical operation. Review of the recent literature indicated that breast cancer of the first stage without metastasis can be successfully treated with either single operative surgery or combined use of surgery and radiotherapy. No noticeable difference was observed between preoperative and postoperative irradiation. For those in the second or more advanced stage with axillary metastasis, a favorable result is expected from combined therapy of surgery and irradiation. Preoperative radiotherapy proved to be approximately 10.0% more effective than postoperative irradiation. The use of ⅔ of total dosage in preoperative radiotherapy with dosage for additional postoperative irradiation was decided depending upon the state of metastasis. In advanced cancer, radiotherapy should be given sufficiently, i.e., 3 to 4 weeks, and radical surgery is indicated providing remnant tumor is observed. (NSA of Japan)

23294 RADIOTHERAPY OF ESOPHAGEAL CANCER. Kimura, Shuji; Yoshida, Mineo (Kobe Univ., Japan). Gan No Rinsho, Suppl.; 149-53(Nov 1969). (In Japanese).

The clinical data on esophageal cancer are tabulated according

to the new TNM classification that was prepared by U.I.C.C. The categorization by site of tumors include: Region I=Ce (from the upper end of the esophagus to suprasternal plan); Region II=Iu (to the lower end of the tracheal branch) + Im (lower part of the tracheal branch and the upper half of the introitus esophagi); and Region III=Ei (lower half of the introitus esophagi) + Ea (abdominal esophagus). Clinical experience with esophageal cancer treated with telecobalt radiotherapy is also reviewed. Angiography proved to be useful in finding the conditions of the mediastinal septum. The morphological classification of tumors in radiograms is also useful in establishing therapeutic plans and estimating prognosis. Indications for surgical treatment and radiotherapy or combined use of the two are discussed. For radical treatment, high-energy radiotherapy is widely used. In ^{60}Co irradiation, relatively satisfactory dose distribution can be obtained by frontal pendular irradiation in Region I; rotational irradiation in Region II and the abdominal esophagus in Region III. The effectiveness corresponds to the degree of progress of tumors and the establishment of early diagnosis is most desirable. (NSA of Japan)

23295 MEASUREMENT OF DOSE TO THYROID CARCINOMA METASTASES FROM RADIO-IODINE THERAPY. Scott, J. Stewart (Glasgow Inst. of Radiotherapeutics); Halnan, K. E.; Shimmins, J.; Kostaki, P.; McKenzie, H. Brit. J. Radiol.; 43: 256-62(Apr 1970).

In individual metastatic deposits of thyroid carcinoma in five patients, the uptake of ^{131}I, the volume of tissue in which the activity is distributed, and the rate of change of this activity with time were measured. These measurements are made from repeated scans of the deposits in two planes and from them the radiation dose to the lesion can be calculated. The estimated doses correlate well with the clinical responses observed. Plans are discussed for relating one or two tracer dose measurements of uptake to the dose that would be obtained from a therapeutic administration and thus to select or reject patients for radio-iodine therapy. (auth) (UK)

Blast and Thermal Effects

23296 EXAMINATION OF HUMAN DIAPHRAGMS FOR TRICHINOSIS IN HIROSHIMA AND NAGASAKI. Gould, S. E.; Ozaki, Hiroyuki; Kimura, Kazuo (Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki). Acta Pathol. Jap.; 18: 245-7(May 1968).

Diaphragms were examined for evidence of trichinosis at autopsies performed at the Atomic Bomb Casualty Commission in Hiroshima and Nagasaki. Diaphragms from 186 cadavers (149 Hiroshima, 37 Nagasaki) were examined by one or more of the following methods: digestion (184), compression (178), and microscopic section (181). No instance of trichinous infection was found by any method. The distribution of the sexes among the autopsies was 82 males (59 Hiroshima, 23 Nagasaki), and 104 females (90 Hiroshima, 14 Nagasaki). In Hiroshima, the age distribution by decades was: first decade (0 to 9 years), 1; second (10 to 19 years), 1; third, 2; fourth, 6; fifth, 4; sixth, 7; seventh, 49; eighth, 42; ninth, 27. In Nagasaki, the distribution was: third decade, 1; fourth, 1; fifth, 4; sixth, 3; seventh, 8; eighth, 13; ninth, 6; tenth, 1. The youngest person examined was 8 years old; the oldest, 95; the median age of persons in each city was 71 years. The negative results from the above small series of autopsies do not confirm the absence of human infection with Trichinella in Hiroshima and Nagasaki. Other reports of trichinous infection in animals in Japan are cited. (BBB)

Radiation Effects on Animals

Refer also to abstract 23407.

23297 (CONF-690501–, pp 799-822) STUDIES OF NORMAL AND RADIATION-INDUCED CELL CHARACTERISTICS IN POSTNATAL RAT HIPPOCAMPUS. Brownson, Robert H. (California Univ., Davis); Price, David C. (California Univ., San Francisco); Jones, Margaret Z. (Medical College of Virginia, Richmond); Welch, Graeme P. (California Univ., Berkeley).

This paper is a preliminary report on the fascia dentata of the immature rat hippocampus including autoradiography and light and electron microscopy. A group of male Sprague–Dawley rats, 15 and 30 days of age, received single head exposures of 2.5 krad of 40-MeV protons and were sacrificed at 2 days, 3 days, 1 week, and 2 weeks after irradiation. Normal and irradiated tissues were processed together for regular and fine-structure details with special attention given to postirradiation factors. Evidence of postirradiation changes in morphology noted in the stratum granulosum of the 15-day-old rat fascia dentata was significantly less when irradiation took place at 30 days of age. The granule cells from the irradiations at the earlier age demonstrated morphologic changes, including moderate cell changes and interstitial swelling in the deep portion of the stratum granulosum. Reaction to injury increased during the first week after irradiation and returned to normal by the end of the second week. Although rats irradiated at 30 days showed little or no cell reaction 2 and 3 days following irradiation, modest changes were observed at the end of the first week which returned to normal by the end of the second week. Early swelling between adjacent 15-day granule cells or undifferentiated granule cells was confined to the extracellular space. Three days after exposure the extracellular space was significantly reduced concomitant with a noticeably enlarged intracellular space. The enlarged intracellular space was identified as a watery cytoplasm with few organelles and some fibrils, suggesting that astrocytes were involved. Both intracellular and extracellular compartments appeared morphologically normal 2 weeks following irradiation. A second group of animals, 17 days of age, received 1.0 μCi of ^{3}H–TdR per gram of body weight by intravenous injection at intervals of 1 hr, 1 day, and 5 days prior to a 4-krad exposure of 44-MeV protons to a restricted area of the head. All animals were sacrificed 6 hr after irradiation, and autoradiography was performed on thin sections of brain tissue. The tissue was coated with Ilford L-4 emulsion, exposed for 28 days, and stained with cresyl violet. The dentate gyrus of the dorsal hippocampus was assessed for labeling patterns particularly in the pyknotic nuclei. Significantly greater labeling of pyknotic nuclei at the 5-day interval is consistent with the postulate that radiosensitive cells have migrated into the area some time after DNA synthesis. (auth)

23298 (CONF-690501–, pp 841-55) INCORPORATION OF TRITIATED THYMIDINE INTO IRRADIATED SPINAL CORDS OF IMMATURE RATS. Gilmore, Shirley A. (Arkansas Univ., Little Rock).

Previous studies demonstrated that ionizing radiation can destroy cells in the immature spinal cord. Little is known, however, about the ability of these cells to recover from radioinduced damage. This paper deals with an autoradiographic study of the incorporation of ^{3}H–TdR into cells of irradiated spinal cords. Soft x rays (total dose, 4000 R) were directed to localized portions of the spinal cords in 3-day-old rats. A single injection of ^{3}H–TdR was made into each rat at an interval from 7 through 15 days following irradiation. The animals were killed from 4 hr to 7 days after injection. The spinal cords were fixed in PO_4-buffered formalin, embedded in paraffin, sectioned, and mounted on slides. Autoradiographs, prepared by the dripping method, were examined with the light microscope following exposure, development, and staining. The results showed that at no time was there a heavy labeling of neuroglia. In contrast, by 11 and 15 days following irradiation, many vascular cells were heavily labeled. The limited labeling seen in neuroglia is an agreement with previous observations; the heavy labeling of many vascular cells was unanticipated when considered in light of recent studies in this laboratory. The significance of these results is discussed. (auth)

23299 (CONF-690501–, pp 955-61) THE SENSITIVITY OF RAT, MONKEY, AND HUMAN OOCYTES TO X RADIATION IN ORGAN CULTURE. Baker, T. G. (Edinburgh, Univ., Scotland).

Ovaries derived from immature rats and monkeys and human fetuses were maintained in organ culture up to 15 days. One ovary of each pair served as a control; the other was exposed to x rays. The doses of radiation used (rat, 148 and 300 R; monkey, 5000 and 7000 R; and human, 2000 and 4000 R) were chosen with the aim of destroying 50 to 100% of the oocytes within 8 days of exposure. The effect of the treatment was assessed by counting the oocytes in every 20th of 40th section of serially sectioned control and irradiated ovaries. The results showed that the majority of oocytes in the rat and monkey are destroyed following x-ray doses of 300 R and 7000 R, respectively. These doses are, however, slightly less effective in vitro than they are in vivo, possibly owing to the absence of pituitary hormones in the nutrient medium. Germ cells in the ovaries of human fetuses appear more resistant than those in the monkey. The depletion in the population of oogonia and oocytes is roughly comparable following exposure of fetal human ovaries to 4000 R and of coeval monkeys to 2000 R. (auth)

23300 PROGRESSION OF VIABLE AND NON-VIABLE SYNCHRONIZED CHINESE HAMSTER CELLS INTO THE S PHASE AFTER X-IRRADIATION IN MITOSIS OR THE S PHASE. Dewey, W. C.; Robinette, S. M. (Colorado State Univ., Fort Collins). Int. J. Radiat. Biol.; 16: 495-500(1969).

Cell multiplication and traversal of cells through the first and second cycles after irradiation were studied in synchronized cells irradiated with doses required to kill about 90% of the cells. The main conclusion drawn was that when 86% to 96% of the cells were

sterilized by irradiating the populations in either the radiosensitive mitotic phase or in the radioresistant S phase, the kinetics for incorporation of ^{3}HTdR into DNA following irradiation were not greatly different. During the second cycle following irradiation, there was a 1 to 3 hour delay in the entrance of the irradiated cells into the S phase, and both populations incorporated ^{3}HTdR into DNA during the second cycle at about the same reduced rate compared with the rates observed in the control cells and in those viable cells surviving irradiation. (UK)

23301 THE EFFECT OF IRRADIATION UPON TRICHOMONAS VAGINALIS. Jedrzejczak, Wanda. Wiad. Parazytol.; 15: 277-8(1969). (In Polish).

The effect of ^{60}Co γ rays on three generations of 12-week culture of Trichomonas vaginalis. Different doses of irradiation from Grammocell 200 as a source were used. The intensity of irradiation at the time of experiment was 160,000 rad per hours. Cultures (24-hr) were irradiated and the results were collected after 48-hr incubation. The multiplication, shape, and behavior of organisms irradiated with different doses were compared to those of a control group. It was stated that the generation after irradiation at 8, 16, 24, and 32 thousand rads did not demonstrate any morphological differences among them, nor as compared to the control group. The generation irradiated with 120, 160, 200, and 320 thousand rads showed marked difference of multiplication. The generation irradiated with 120 and 160 thousand rads showed delayed (for 10 days) division of the cells as compared to the control group. Protozoans irradiated with these doses showed morphological changes. The generation of Trichomonas after 200 and 320 thousand rads irradiation did not multiply in subsequent passages. (auth)

23302 X-RAYS AND NITROGEN MUSTARD: INDEPENDENT ACTION IN CHINESE HAMSTER CELLS. Sakamoto, K.; Elkind, M. M. (National Cancer Inst., Bethesda, Md.). Biophys. J.; 9: 1115-30(Sep 1969).

The combined effects of irradiation and nitrogen mustard treatment on the colony-forming ability of Chinese hamster cells were studied. In contrast to x irradiation, nitrogen mustard acting by itself yielded an exponential dose-effect relationship. Whether delivered in immediate sequence or after varying intervals, nitrogen mustard treatment did not affect radiation survival. These results, plus the lack of any indication of the repair of sublethal nitrogen mustard damage, were consistent with independent but different modes of action at the same site or action at different sites. Actinomycin D showed a clear indication of an ability to interact with x-ray damage when measured either relative to single or fractionated x-ray doses. It was concluded that in view of its binding specificity for DNA, actinomycin D and radiation interacted probably because they acted at the same locus and in mammalian cells this locus involved the DNA of the cell. Nitrogen mustard survivors survived irradiation as though they had received no prior treatment. While a cell surviving irradiation was sublethally damaged, any subsequent damage due to nitrogen mustard was adequate to kill it. Hence, x-ray survivors, regardless of the status of their sublethal damage survived nitrogen mustard exposure as though they had received no prior treatment. The lack of an interaction between nitrogen mustard and radiation damage was consistent with a common locus of action. It was concluded that the lesion due to this alkylating agent was in or associated with a cell's DNA, as other results indicated for x-ray lesions, and still may not interact with radiation damage because of essential differences in the damage resulting from these agents. The results were taken as example of independent actions involving the same target molecule. (BBB)

Invertebrates

Refer also to abstracts 23161, 23163, 23166–23168, 23415–23417, 23419, and 23421.

23303 (ORO-2412-26) EFFECTS OF SALINITY AND IONIZING GAMMA IRRADIATION ON THE DEVELOPMENTAL STAGES OF THE ANTHURID ISOPOD, CYATHURA POLITA (STIMPSON). Kelley, Bernard Joseph McLain Jr. (Emory Univ., Atlanta, Ga.). 1969. 93p. Dep. CFSTI.

Thesis.

An investigation was made of the effects of salinity and ionizing gamma irradiation on osmoregulation, development and hatching of the marsupial stages of the isopod Cyathura polita. Embryos in various stages of development from two St. John's River, Florida populations (Green Cove Springs and Silver Glen Springs) and one Cape Cod, Massachusetts population (Pocasset River) were used. In accordance with Strömberg's definitions of stages, a timetable of development was assembled from durations of individual stages in natural water. Observations were made of the effects of salinity (0, 0.5, 10, 20, 30 and 40‰) on hatching and on rate and quality of development of irradiated (22 and 44 kr) stage 5 (metanauplius) embryos and non-irradiated embryos in various stages. Measurements were taken of the diameter of the blastular cell mass of stage 2 embryos in salinities of 0, 10, 20, 30 and 40‰ with the extra-embryonic membranes intact and with these membranes torn. A similar experiment using stage 6 (larval) embryos was also done. Finally, freezing point determinations (ΔF) were made of extra-embryonic fluid in membrane bounded stages (1 through 6) and of body fluids in stages 7 and 8. All embryos were acclimated to 0, 0.5, 10, 20, 30 or 40‰ salt solutions for 24 hours. ΔF's were also determined on extra-embryonic fluid of irradiated stage 5 (metanauplius) embryos that received 22 or 44 kr of ionizing gamma irradiation and were acclimated in the various salinities for 24 hours. The results of these experiments show that embryonic C. polita is a hyperosmotic regulator in lower salinities (0 to 20‰), but has varied responses, including hyper-, hypo- and isosmotic regulation in higher salinities (30 to 40‰), depending upon the stage of development. The shedding of extra-embryonic membranes seems to be an osmotic process. Inhibition of shedding was observed in salinities of 30 or 40‰. ΔF's of extra-embryonic fluids are favorable to water uptake before and during hatching except in the highest salinities. The range of salinities in which normal development occurs is between 0 and 30‰ for St. John's River cyathurans. Developmental aberrations were observed in embryos from late stage 5 to stage 7 (metanauplius to juvenile) in salinities of 0, 30 and 40‰. Latitudinal differences in osmoregulation capacity were observed between stage 8 cyathurans from Florida and Massachusetts. Massachusetts cyathurans were hyposmotic in 30 and 40‰; Florida cyathurans were not significantly different from the medium in 30 and 40‰. A mechanism is suggested which employs the accumulation of osmotically active metabolites to account for the hyperosmotic regulation patterns that were observed in membrane bounded stages. Radiation is discounted as an important environmental factor influencing osmoregulation in stage 5 (metanauplius) embryos, since other life functions are more sensitive to radiation damage than the osmoregulation system. The role of salinity in the ecology of C. polita is discussed. Emphasis is placed on the importance of a salinity tolerance limitation in developmental stages to distribution, dispersal and gene exchange between populations in different estuaries. An appendix is included which presents the unanalysed data from all experiments that yielded quantitative results. (auth)

23304 NORMAL DEVELOPMENT OF ANAPHES FLAVIPES IN CEREAL LEAF BEETLE EGGS KILLED WITH X-RADIATION, AND POTENTIAL FIELD USE. Barton, Larry C.; Stehr, Frederick W. (Michigan State Univ., East Lansing). J. Econ. Entomol.; 63: 128-30(Feb 1970).

The egg parasite Anaphes flavipes (Foerster) completed normal development of the F_1 generation in cereal leaf beetle, Oulema melanopus (L.), eggs sterilized with 3000 to 5000 R of x radiation. The F_2-generation completed normal development in nonirradiated eggs. Inundative releases of A. flavipes for control of the cereal leaf beetle are deemed impractical. The addition of sterile eggs in the field to provide additional resources for early-season buildup of A. flavipes is of unknown value. (auth)

23305 DIFFERENTIATION OF OMMATIDIUM-FORMING CELLS OF DROSOPHILA MELANOGASTER IN ORGAN CULTURE. Kuroda, Y. (National Inst. of Genetics, Sizuoka, Japan). Exp. Cell Res.; 59: 429-39(Mar 1970).

Eye-antennal discs isolated from mature third-instar larvae (96 hr after hatching at 25°C) were cultivated in a chemically defined medium K-6'. In the presence of ring glands, ecdysone secreting organ, or ecdysone analogues of plant origin in the medium, a pronounced organization of ommatidium-forming cells in the eye disc portions was observed after 24 hr of cultivation. Trypsin-dissociated eye-antennal disc cells formed in rotation culture cell aggregates in which prospective ommatidium-forming cells sorted out from other types of cells of eye-antennal discs. In the presence of ecdysone analogue, BUdR, actinomycin D and puromycin had no inhibitory effect on the differentiation of ommatidia in cultured eye-antennal discs. X irradiation with 2000 R demonstrated that there would be a differential sensitivity to x ray in the differentiation of ommatidia at different stages of cultivation. Implications of these inhibitor effects of macromolecular syntheses and x irradiation on the organization of ommatidium-forming cells are discussed. (auth)

23306 LD_{50} EMERGENCE AND β PARAMETERS AS CRITERIA OF SENSITIVITY TO GAMMA RADIATION IN ACHETA DOMESTICUS. Jobin, L. J.; Huot, L.; Perron, J.-M. (Univ. Laval, Quebec). J. Econ. Entomol.; 63: 114-19(Feb. 1970).

Dosage-mortality studies in response to γ rays were carried out

on eight embryonic and five nymphal stages of a hemimetabolous insect, the house cricket, Acheta domesticus (L). The radiation sensitivity during preimaginal development, measured as degree of subsequent adult emergence, showed that sensitivity depends on the dose administered and the stage irradiated. The LD_{50} emergence of the 1st embryonic stage was higher than that of the next four stages studied, which were the most sensitive to radiation. The LD_{50} values then increased gradually until the last nymphal stage. The slopes of the dosage-mortality regression curves (β parameters) indicated that sensitivity to ionizing radiation evolves in two phases related to differential cellular activity and degree of tissue differentiation. The use of β parameter is proposed as criterion of value for comparative studies with radiation. The present work provides a rather complete account of the pattern of sensitivity observed in a series of developing embryos and nymphs of A. domesticus following exposure to low doses of radiation administered at a low dose rate. (auth)

23307 ALTERATIONS IN SPERMIOGENESIS OF LOCUSTA MIGRATORIA MIGRATORIOIEDES AFTER CORPORA ALLATA IMPLANTATION AND AFTER IRRADIATION. Cantacuzene, Anne-Marie; Ceureau, Claude (Laboratoire de Biologie Animale C, Paris). Z. Zellforsch. Mikroskop. Anat.; 103: 351-64(1970). (In French).

Low doses of γ rays, given to larvae of Locusta migratoria, lead to alteration of spermiogenesis and male sterility. Theses results are similar to those that follow Corpora allata implantation. At the cellular level, morphological alterations in spermatids are the same in both treatments: mitochondrial vacuolization, nuclear pycnosis, centriole multiplication, plasmic membrane invagination. Some of these alterations reveal themselves late, at the time the spermatids fix on the parietal cells. These don't elaborate the substances of the spermatodesm's cap: their physiological functions are therefore also disturbed. The relation between this physiological disturbance and abnormal evolution of spermatids are considered and the way in which juvenile hormone acts upon gonads is discussed. (auth)

Vertebrates

Refer also to abstracts 23074, 23082, 23083, 23103, 23106–23110, 23112–23114, 23122–23124, 23127, 23157–23160, 23174, 23192, 23237–23241, 23244, and 23409.

23308 (AD-696447) LASER RADIATION EFFECTS ON THE MORPHOLOGY AND FUNCTION OF OCULAR TISSUE. Final Report, August 1, 1968–July 31, 1969. Jones, Arthur E.; Spyropoulos, Perry; Massof, Robert W. (Honeywell, Inc., St. Paul, Minn. Research Dept.). Aug 1969. Contract DADA17-67-C-0019. 37p. CFSTI.

The effects of different energy levels of ruby laser radiation on electrophysiological, psychophysical and anatomical parameters were examined in the eyes of monkeys. Spectral sensitivity tests, using an ERG analysis, demonstrated prolonged laser effects on rhesus and mangabey monkeys. At 15-months post-exposure for the rhesus monkey, the amplitude of the b wave was depressed at all wavelengths except 420 nm. At one-year post-laser exposure for the mangabey monkey, the amplitude of the b wave was depressed at all wavelengths and the amplitude of the b wave as a function of intensity at 570 nm was depressed by about 20% at high intensity and not affected at low intensity. Also, the third oscillatory potential remained absent. An ERG analysis of the Rayleigh match demonstrated that rhesus monkeys have normal color vision, that squirrel monkeys are protanomalous, and that owl monkeys are monochromatic. Following laser exposure of two rhesus monkeys the match was unbalanced in favor of the green component, indicating a protanomalous response. Behavioral studies of two rhesus monkeys, one laser exposed at 1.8J/sq cm and one exposed at 0.18J/sq cm, demonstrated a reduction in sensitivity at all but two spectral points for the monkey exposed at 1.8J/sq cm and no significant change in the sensitivity of the monkey exposed at 0.18J/sq cm. The latter monkey did, however, show a marked change in the shape of the function indicating an anomalous finding. (auth) (TAB)

23309 (CONF-690414-2) EPIDEMIOLOGICAL AND CELLULAR EFFECTS OF CHRONIC RADIATION EXPOSURE: A SEARCH FOR RELATIONSHIP. Sacher, G. A.; Grahn, D.; Fry, R. J. M.; Rust, J. H. (Argonne National Lab., Ill. Chicago Univ. Ill. Dept. of Pharmacology). [1969]. 38p. Dep. CFSTI.

From 1st European Symposium on Late Effects of Radiation, Rome, Italy.

The life shortening and disease incidence produced by chronic γ irradiation are analyzed, especially the findings in a recently completed experiment on the two sexes of four genotypes of mice given daily dosages from 0.3 to 56 R/day. The pattern of the age-specific mortality rate for reticular tissue tumor indicates that there is a maximum in the incidence rate curves at all daily dosages from 6 to 43 R/day. The turnover occurs in each case at an accumulated effective dose of about 3000 R. The applicability of Gray's two-stage theory to these data and the data from three other tumor types is discussed. The mortality rate data for all causes except leukemia indicate that excess mortality from these causes varies exponentially with daily dose, and has no measurable long-term recovery component. The effects of chronic irradiation on cellular mechanisms are examined. The lengthening of the generation cycle in duodenal crypt cells is singled out as a possible model system for a cumulative biochemical lesion related to the life-shortening effect. Some of the undecided alternative hypotheses are examined to provide a basis for discussion of possible future experiments. (auth)

23310 (CONF-690501) RADIATION BIOLOGY OF THE FETAL AND JUVENILE MAMMAL. Proceedings of the Ninth Annual Symposium, Richland, Washington, May 5–8, 1969. Sikov, Melvin R.; Mahlum, D. Dennis (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. 1026p. Dep. CFSTI.

Separate abstracts were prepared for 79 of the 84 papers appearing in this symposium. Abstracts of the other five papers appeared previously in NSA. For reference to these abstracts see CONF-690501. (E.R.B.)

For abstracts of individual papers see: 23052, 23068–23084, 23103–23108, 23192, 23193, 23297–23299, 23311–23353, and 23379–23385.

23311 (CONF-690501–, pp 1-6) DEVELOPMENTAL RADIOBIOLOGY. Noonan, Thomas R. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Following a brief summary of past symposia and published reviews on the prenatal effects of ionizing radiation and other teratological agents, the stages of prenatal development are defined and the radiosensitivity of each stage indicated. The growth of our understanding of mammalian prenatal development and the diversity of interests, internationally, in prenatal or developmental radiobiology are evident in the fact that the bounds established for this symposium were narrowed in order to adequately present the data resulting from the increased research activity in this area. (E.R.B.)

23312 (CONF-690501–, pp 45-62) CONCENTRATION, DISTRIBUTION, AND EFFECTS OF RADIOIODINE IN EMBRYONIC GUINEA PIGS DURING EARLY ORGANOGENESIS. Nelson, Neal S.; Stara, Jerry F. (Bureau of Radiological Health, Rockville, Md.); Hoar, Richard M. (Cincinnati Univ., Ohio).

Iodine absorption, retention, and distribution were studied in pregnant guinea pigs and their fetuses 24 hr after a single oral dose of ^{131}I. The dams were whole-body counted and sacrificed, and samples of maternal blood, maternal thyroid, fetal placenta and membranes, yolk sac, and embryos were weighed and assayed for ^{131}I content. Some embryos were fixed, embedded, and sectioned, and autoradiographs were prepared from representative sections for evaluation of local distribution. Data were collected for days 10 to 22, inclusive, and days 26 and 30 of the gestation period. An attempt was made to produce congenital defects in guinea pigs by administering ^{131}I daily for 6 days, starting on day 7, 11, 15, or 19 of gestation. Half of the pregnant females were sacrificed after 30 days of gestation, and the embryos were weighed, measured, and examined histologically and for developmental abnormalities. The remainder of the pregnant females were allowed to reach parturition, after which neonates were observed for developmental and metabolic defects. The data obtained suggest that: iodine uptake and retention by the guinea pig is lower than that of most other mammals; the fetal guinea pig thyroid gland initiates function at between 20 and 22 days of gestation; the fetal placenta functions as a barrier to iodinated compounds, a storage depot for iodine, or both; iodine deposits in the choroid coat of the fetal eye at all stages of development studied; the ^{131}I deposition pattern in fetal thyroids resembles that of adult thyroids after the 25th day of gestation; and administration of ^{131}I for 6-day periods during organogenesis produces increased prenatal body weight, and a bilateral infolding of the retina in 63.5% of exposed 30-day embryos. (auth)

23313 (CONF-690501–, pp 229-42) RADIATION-INDUCED TERATOGENESIS IN RELATION TO SEASON AND SOME FEATURES OF REPRODUCTION BIOLOGY. Jacobsen, Lars (Univ. Inst. of Medical Genetics, Copenhagen, Denmark).

Mouse fetuses exposed to low doses of x rays were studied to evaluate the possible influence of season and of certain features of reproduction biology on the dose effects and to ascertain

whether any features appertaining to the pregnancy itself could either camouflage or exaggerate the consequences of irradiation. The possible influences to be considered are season, maternal age and weight at the time of conception, litter size, and the intrauterine position of the fetuses. Mice of the HC strain were irradiated with 5, 20, and 100 R of x rays (12 ma, 175 kV) on the 8th day of pregnancy and examined on the 19th day of pregnancy. The dose rate was 50 R/min. Skeletal defects were the major set of traits studied. The control group comprised 2857 young; the 5-R group, 2278 young; the 20-R group, 527 young; and the 100-R group, 106 young. The observed quantitative differences between summer and winter results are so large that dosage response would have been submerged at various dose levels had results not been recorded according to seasons. The summer samples reveal themselves to be less radiosensitive than the winter ones. It may be concluded that observations of teratogenic effects made in different seasons should be analyzed separately. Maternal age and weight variations at the time of conception are associated within each dosage group with slight variations in incidences of certain of the traits studied. These variations are quantitatively so small that misinterpretation of dose effect on this account is not regarded as a potential source of error. Litter size was found to have an important influence upon the observed effects. For this reason, all data should be analyzed with respect to litter size before interpretation of teratogenesis is undertaken. Statistical evaluation of the present data indicates the litter size variations have not had a quantitative effect upon the results, such that dose effects may have been masked. But litter-size variations shall be stressed as an important factor in small experimental groups. The factor of position of the individual fetuses in the uterine horns does not appear to have influenced dose effect and does not render the experimental groups less comparable. (auth)

23314 (CONF-690501–, pp 243-50) EFFECT OF DOSE RATE ON PRENATALLY IRRADIATED LAMBS. Murphree, R. L.; Graves, R. B. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Previous studies at this laboratory showed that total-body irradiation (400 R of ^{60}Co at 0.5 to 0.6 R/min) of pregnant ewes on the 22nd to 25th days of gestation resulted in leg deformities in all the lambs. The malformations consisted of fusion of the humeroradial joints or absence of the femurs, or both. This study was performed to determine the effects of variations in dose and dose rate on lambs irradiated on the 23rd day of gestation. In the first trial, 80 pregnant ewes were exposed to an air dose of 282 R from ^{60}Co (40 at 1 R/min and 40 at 47 R/min). In the 1 R/min and 47 R/min groups, six and 15 ewes died 18 to 35 (av. 23) days postexposure, respectively. None of the eight fetuses recovered from seven of the ewes after death were of the size expected for their age. Vestiges of fetal membranes were found in the uteri of other ewes on autopsy. In the 1 R/min group, four ewes gave birth to four deformed lambs, and in the 47 R/min group, one ewe produced twins, one of which was deformed. Among these five deformed lambs, three showed aplasia of the ulnae only and two showed aplasia of the ulnae and femora. In the second trial, 40 pregnant ewes were exposed to an air dose of 188 R (20 at 1 R/min and 20 at 47 R/min). In the 47 R group, two ewes died after they had been irradiated; both were pregnant. Of 28 lambs born by 19 ewes in the 1 R/min group, 10 were deformed. Among the 10 abnormal lambs in the 1 R/min group, nine had abnormal legs, two had the right eye missing (one of these also had abnormal legs, and one had a grossly malformed head (it also had abnormal legs). In contrast, only one of 29 lambs born by 17 ewes in the 47 R/min group was deformed. Only the legs were malformed. (auth)

23315 (CONF-690501–, pp 251-62) EFFECT OF FRACTIONATED X IRRADIATION ON THE DEVELOPMENT OF THE MAMMALIAN FETUS. Kriegel, Heinz; Reinhardt, Stefan (Gesellschaft fuer Strahlenforschung, Munich, W. Ger.).

After fractionated whole-body x irradiation with differerent radiation doses during gestation, pregnant mice were killed at day 18, and the fetuses were examined for malformation and radiation damage. The irradiation doses were 80, 120, and 160 R/day during days 11 to 16, 11 to 13, and 14 to 16 postconception, respectively. It was shown that the striking visible effects of radiation were responsible for growth retardation of the fetuses. The embryos as a whole were stunted and, except for tail and extremity malformations, no evidence of abnormalities appeared. Growth inhibition and visible malformations depend on the radiation dose and the developmental stage at exposure. A dose of 80 R/day given at the end of the organogenesis, in the early fetal period, and during both developmental stages is not sufficient to influence the development and the differentiation of the embryonic tissue. Such visible abnormalities as malformed tails, extremity abnormalities, and edematous fetuses were observed after daily exposures with 120 R and 160 R but only if the irradiation occurred during days 11 to 16 or 11 to 13 postconception. Previous histological examinations showed damage to the brain and other organs. (auth)

23316 (CONF-690501–, pp 263-82) RADIATION EFFECTS PRODUCED IN PREGNANT RATS AND THEIR OFFSPRING BY CONTINUOUS INFUSION OF TRITIATED THYMIDINE. Fliedner, T. M.; Haas, R. J.; Bohne, F.; Harriss, E. B. (Ulm Univ., W. Ger.).

The effects of the continuous administration of various doses of tritiated thymidine (^{3}H–TdR) to pregnant rats from day 9 until day 22 of pregnancy were studied in the mothers and their offspring. Doses of 1.6 μCi/g/day were tolerated well, did not produce any injury to the pregnant rats, and did not impair significantly the general nor the hemopoietic development of the offspring. Higher doses (3.2, 4.8, and 6.4 μCi/g/day) resulted in a marked bone-marrow depression followed by a rapid regeneration after discontinuation of ^{3}H–TdR administration in the pregnant rats. An increasing frequency of stillborn rats or early fatality was found in relation to the amount of ^{3}H–TdR given to the pregnant animals. Furthermore, the neonatal growth (weight and length) as well as the development of the blood-cell-forming tissues was the more impaired the higher the ^{3}H–TdR dose has been to the mother. Pregnant rats given 8.0 μCi/g/day had malformed fetuses at the time of expected delivery, that indicated the abnormality of the development of several organs including the brain. The retardation of the hemopoietic development is assumed to be related to the impairment in the development of a normal-size determined stem-cell pool. (auth)

23317 (CONF-690501–, pp 283-7) SOME EFFECTS OF TRITIATED WATER ON MAMMALIAN FETAL DEVELOPMENT. Cahill, Daniel F.; Yuile, Charles L. (Rochester Univ., N. Y.).

Female Sprague–Dawley rats have been maintained throughout pregnancy at equilibrium body-water levels of tritium of 10, 50, and 100 μCi/ml by means of ad libitum ingestion of tritiated water supplies. These levels provided approximately 3, 15, and 30 rads/day of total-body radiation to the embryo and fetus during the 22-day gestation period. The intermediate and high doses produced measurable effects: decreased litter sizes, decreased weights of offspring, stunting, and evidence of microcephaly. The weights of the fetal brain, heart, thymus, spleen, kidney, and testes were reduced. Tritium analyses of equilibrated, dried organs indicated that the level of organically bound tritium in tissues was directly proportional to the body-water activity. The level of ^{3}H in the organic components of fetal brain, lung, heart, kidney, thymus, and spleen approximated 20% of the activity in the water of these tissues; incorporation into liver was somewhat lower. The results of histologic evaluation of a number of fetal tissues and observations on the postnatal development subsequent to intrauterine exposure will be reported. (auth)

23318 (CONF-690501–, pp 289-300) BEHAVIOR, MOTILITY, AND ANATOMICAL FINDINGS IN MICE SURVIVING PRENATAL IRRADIATION. Ostertag, Berthold (Tubingen Univ., W. Ger.).

Mice surviving embryonal intrauterine x irradiation of 180 R and unirradiated littermates were examined both clinically and pathologico-anatomically. The genesis of the changes observed is discussed. While irradiation up to the 8th day of gestation will mainly damage the blastema, irradiation after the 8th day of gestation will affect existing structures; reactive changes appear (simple defects, scars, etc.). This must be discriminate. Transitory hyperplastic reactions in the nerve tissue were observed. Irreversible hyperplasia of the cerebral meninges and the plexus, which can be progressive, followed by proliferation of the arachnoid cells and disturbances of the spinal cord are similar to human dysraphias that were also seen. An actual tumor, a meningioma, as found in man, was found only once. The question of abiotrophy of single elements, such as Purkinje's cells of cerebellum is discussed. The data are restricted mainly to effects on the central nervous system and axial skeleton of young mice that received intrauterine irradiation (on one side only) of the 180 R on the 11th day of gestation. (auth)

23319 (CONF-690501–, pp 301-12) CONDITIONING STUDIES WITH PRENATALLY IRRADIATED RATS. Furchtgott, Ernest; Walker, Stephen F. (Univ. of Tennessee, Knoxville).

In the Soviet Union there were numerous studies of conditioning with prenatally irradiated rats. With a response-independent reinforcement technique (Kotlyarevsky), changes were reported after doses ranging from 1 to 20 R. These Soviet findings are in sharp contrast to the few United States conditioning studies in which radioinduced deficits were observed only after doses of 150 R or more. The methods used, however, differed considerably from the Soviet techniques. The present studies were performed in an attempt to replicate Soviet findings. Albino rats were exposed to doses of 50 to 200 R of 250 kVp x radiation on day 16 of gestation.

Beginning at 80 days of age, the animals were tested either with a modified Kotlyarevsky technique or with standard operant conditioning methods. With the Kotlyarevsky technique, animals exposed to 200 R showed slower acquisition of conditioned responses to a 400 cycle/sec tone than controls. The magnitude of the differences, however, was not very great. In subsequent studies animals exposed to 100 or 50 R on day 16 seemed to show only minimal differences from controls. Few differences, even with the 200-R group, could be discerned in the establishment of a differentiation between a 400 and an 800 cycle/sec tone. The findings indicated that the initial differences in conditioning were probably associated with differences in arousal. With standard operant conditioning techniques in a light-dark discrimination, 200-R animals were inferior to controls when bar pressing was continuously reinforced in the light and not in the dark. The irradiated animals were similar to controls, however, when bar pressing in the light was reinforced on a fixed interval. The relation of these results to other behavioral data is discussed. (auth)

23320 (CONF-690501–, pp 313-24) THE EFFECT OF ^{90}Sr ON THE OVARIES OF THE FETAL MOUSE. Nilsson, Agnar (Research Inst. of National Defence, Sundbyberg, Sweden); Henricson, Bengt (Royal Veterinary College, Stockholm, Sweden).

The effect of ^{90}Sr on various stages of the fetal ovary was studied. Pregnant CBA mice were injected intravenously with 20 μCi of ^{90}Sr per mouse on the 11th or 16th day of gestation. The young mice were sacrificed at 2, 14, 28, or 56 days after birth. The ovaries were fixed in Stieve's fluid and sectioned serially at 5 μ; every fifth section was examined microscopically. The oocytes were divided into three categories: 1st order, without surrounding granulosa cells; 2nd order, 1 to 4 granulosa cells; and 3rd order, 5 to an almost complete layer of granulosa cells. The follicles were counted and classified as primordial follicles with a complete layer of granulosa cells, growing follicles with two or more layers, early antrum with 2 to 3 layers but with antrum formation, graafian follicles, atretic follicles, and corpora atretica. The total numbers of oocytes and follicles for each ovary were calculated according to the formula of Abercrombie. In groups treated with ^{90}Sr, the number of oocytes of types I to III were reduced to about 50% of that in the control groups. The effect was more pronounced in the mice injected at 16 days than at 11 days after mating. There was a clear tendency toward an accelerated development into growing follicles, as indicated by the appearance of a greater number of follicles with an early antrum. The decreased number of oocytes at any one time was not followed by a proportional decrease of growing follicles at the next time of observation. The numbers of atretic follicles and corpora atretica were more numerous in the ^{90}Sr groups than in the control groups. The total number of graafian follicles was decreased, but this was less prominent than was expected from the reduced number of primordial cells. (auth)

23321 (CONF-690501–, pp 325-40) EFFECTS OF 14.1-MeV FAST-NEUTRON IRRADIATION ON THE CARDIOVASCULAR SYSTEM OF THE RAT FETUS. Okamoto, Naomasa; Ikeda, Takayoshi; Satow, Yukio (Hiroshima Univ., Japan).

It was shown that irradiation of pregnant rats with 130 rads of 14.1-MeV fast neutrons on the 8th day after conception caused malformation of the heart and great vessels to occur in 85% of the fetuses. On the basis of this experiment, the morphological and enzymatic changes in the embryonic heart were studied in greater detail. Pregnant rats were exposed to 130 rads of whole-body irradiation on the 8th day after conception, and embryos were removed at various stages for the examination. Light and electron microscopic observations revealed that the effects strongly appeared 3 hr after irradiation, and the direction of embryonic death or survival seemed to be fixed, that is, primary embryonic death and the repair of acute damages occurred until 24 hr after irradiation. The patterns of LDH-isozyme showed marked variations during 24 hr and gradually returned toward the control range. Two days after irradiation many cases of abnormal looping were observed. The frequencies of retarded development of the heart decreased 6 to 7 days after irradiation, but the cardiovascular anomalies increased at this stage; so the retarded hearts seemed to have a tendency to die or to become abnormal or to form a normal heart. In some myocardial cells large lysosomes were seen that may lead to the death of the cell, and a decrease in the number of cells was seen under a light microscope. The decrease of cells and the disorder of regulation of the developmental process, including disfunction of genes due to direct effects of irradiation or lysosomal indirect affections, are presumed to be the causal factors of cardiovascular anomalies. (auth)

23322 (CONF-690501–, pp 341-56) EARLY RADIATION INJURY TO THE MICROCIRCULATION: RELATION TO MORTALITY. Stearner, S. Phyllis; Christian, Emily J. B. (Argonne National Lab.).

The early response to lethal doses of ionizing radiation in the chicken and the chick embryo is characterized by rapid structural and functional changes in the microcirculation. Increased vascular permeability and degenerative changes of the vessel walls lead to generalized circulatory stasis and death within a few hours after exposure. These effects were observed in the x-irradiated explanted 3-day chick embryo and were recorded cinemicrographically for subsequent study. Within 2 or 3 hr after a lethal exposure delivered in a few minutes (1100 R, exposure time 12 min), the vessel walls became swollen, and circulating cells adhered to localized areas of the endothelium. Thrombi formed in such areas, and occlusion of small vessels and degeneration of the vessel walls followed. Widespread areas of stasis developed, and death frequently occurred within 4 to 6 hr after exposure. Alterations of the vessel walls were rarely observed after radiation doses below the lethal range. Increasing the exposure time from a few minutes to a few hours decreased the dose effectiveness for this injury mechanism; a larger amount of radiation was required to produce the same effect. Degenerative changes in endothelial cells appeared to be a direct effect, and their incidence was reduced when exposure time was increased. Early changes in vascular permeability and in the permeability of extravascular structures, such as basement membrane and ground substance, also have been reported after moderate doses of ionizing radiations in mammalian species, including man; usually, these effects are less severe than in the chicken and are not fatal. In newborn rats, however, an early mortality (<48 hr) after an exposure of 600 to 1000 R of x radiation was demonstrated. The presence of edema, hyperemia, and hemorrhages in the central nervous system indicates that vascular injury was a prominent factor in the lethal response. (auth)

23323 (CONF-690501–, pp 357-64) EFFECT OF IN UTERO X IRRADIATION ON THE PERIPHERAL BLOOD OF THE NEWBORN RAT. Hazzard, DeWitt G.; Budd, Roger A. (Bureau of Radiological Health, Rockville, Md.).

X irradiation was given in utero at 15 days gestation to Sprague–Dawley strain rats at 78 rads/min. The dams were pretreated 1 day before irradiation with either endotoxin, colchicine, or saline, administered intraperitoneally. Hematopoietic changes as reflected in the peripheral blood cells were determined on newborn animals at 1 day after birth. The effects of drugs and radiation were tested at the 120-, 180-, and 240-rad levels, using a balanced 3 by 3 factorial design. The data were analyzed using an analysis of variance. Radiation alone caused significant ($p < 0.01$) linear decrease in white-blood-cell counts. Irradiated animals receiving endotoxin had higher white-blood-cell counts than animals receiving radiation alone. Radiation alone resulted in a significant ($p < 0.01$) linear decrease in body weight, which was, on the average, higher than in irradiated animals receiving either endotoxin or colchicine. Radiation alone caused no significant difference in red-blood-cell counts or hematocrit response. The groups receiving radiation and endotoxin had higher red-blood-cell counts and hematocrit readings than the groups receiving radiation alone. Nucleated red blood cells showed no appreciable changes resulting from radiation alone or in combination with endotoxin or colchicine. (auth)

23324 (CONF-690501–, pp 365-74) EFFECT OF ^{131}I ON THYROID GROWTH IN MOUSE FETUSES. Walinder, Gunnar; Sjoeden, Anne-Marie (Research Inst. of National Defence, Sweden).

The ability of the fetal mouse thyroid to accumulate iodine increases rapidly from the 17th day after conception. This stage of functional development is intimately connected with the inception of colloid formation. Histologically, the mouse thyroid is still irregular at birth and the colloid-bearing follicles are sparsely distributed in a tissue matrix chiefly consisting of actively proliferating epithelial cells. The most spectacular radiation effect on thyroid tissue in the CBA mouse was the impairment of the reproductive integrity of the epithelial cells. Accordingly, the thyroid epithelium in mouse fetuses would be expected to be more radiosensitive than that in adult mice. The ^{131}I dose necessary for impairment of the normal growth of the fetal and juvenile thyroid gland was of the same order of magnitude as that causing a corresponding impairment of the goitrogenic response of the thyroid epithelium in the adult mouse. However, the normal long-term regeneration of thyroid epithelium in the adult mouse can be completely inhibited by fairly low radiation doses, whereas much higher doses are required to cause a corresponding arrest of growth of the epithelium in fetal and juvenile thyroid glands. The difference between the radiosensitivity of fetal and adult thyroids relates to the fact that radiation effects on the reproductive integrity of rapidly proliferating cells can be observed soon after exposure, whereas the corresponding effects in the adult thyroid gland can be seen only after a considerable lapse of time. Several experimental investigations have shown that thyroidal growth promotes the cancerogenic effect of radiation. The hazard of radio-

iodine incorporation is discussed relative to the growth of the immature thyroid and these cancerogenic effects. (auth)

23325 (CONF-690501–, pp 375-9) GROWTH RESPONSE OF RATS TO PRENATAL IRRADIATION AS INDICATED BY CHANGES IN DNA, RNA, AND PROTEIN. Martin, Polly G. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Two studies were performed to investigate changes in body and organ weights and cellular materials in fetuses receiving irradiation on the 18th day of gestation. In the first, 220 R of ^{60}Co gamma rays was given at 2.1 R/min; in the second, 160 R at 3.3 R/min. In both studies the liver, spleen, thymus, and kidneys of irradiated animals of both sexes contained less DNA (cell numbers), RNA, and protein than the controls at each age investigated. The concentration of cellular materials per cell was not consistently different. In the first study, irradiated males and females weighed 86 and 74%, respectively, of controls at birth. At 30 days the irradiated animals of both sexes weighed 54% of controls. Determination of cell numbers at 30, 60, 115, and 160 days revealed differences to be greatest between the two groups of males at 30 days; the liver, spleen, thymus, and kidneys contained 54, 36, 41, and 61% of control values. Cell number (and weight) increased more rapidly in the irradiated males than in the controls between 30 and 60 days, after which time changes were smaller. In the second study, samples were taken from male animals at times between 7 and 60 days. Cell numbers, expressed as percent of controls, indicated that the kidney and liver followed the pattern of body-weight changes: day 7, 74%; day 21, 82%; day 30 70%. Cell numbers in the spleen decreased in relation to controls from day 7, 94%; day 21, 65%; day 30, 48%. The thymus increased in cell numbers from day 7, 42%; day 21, 75%; day 30, 59% of control values. Between 30 and 60 days, the rate of increase in cell numbers in these four organs was greater in the irradiated animals than in the controls. (auth)

23326 (CONF-690501–, pp 381-91) RADIATION EFFECTS ON DEVELOPING EMBRYOS AND FETUSES. Rugh, Roberts (Columbia Univ., N. Y.).

In the remarks of the chairman, the following conclusions were made. The embryo and fetus, in contrast with the adult, have remarkable powers of adjusting to x-radiation insult. This involves discarding, often by phagocytosis, the necrotized cells so that what remains is viable. Embryos and fetuses can be killed in utero by x radiation, but the dose ranges from 10 R to the $LD_{50/30}$ dose for the species, depending entirely upon the developmental (or gestational) stage. Early embryos are either killed outright or survive to appear to be normal. Embryos and fetuses in active organogenesis respond to X rays by developing congenital anomalies of various sorts, depending in large part upon the stage of development at which they are insulted. Even within a single litter exposed to the same field of ionizing radiations, there can be as many different responses as there are members of the litter. This does not imply variations in exposure but rather genetic variations in their response to the same radiations. Even within a single individual there may be a wide range of response between bilaterally symmetrical organs that are normally identical. This variation may be explained on slight differences in radiation depending upon the position of the fetus within the field of exposure. This conclusion does not contradict the previous one. When the x radiations occur at a time when the formative cells are less abundant, the result may be stunting in which the fetus is topographically normal but reduced in all its parts because of deficient cells with which to build its organs. There is no evidence that x radiations that can damage differentiating cells have any proliferating effect on the undamaged cells. The phenomenon of regeneration via accelerated cell division has not been seen. The chromosome is probably the chief target through which x radiations cause congenital anomalies. The chromosome and its DNA are particularly radiosensitive. Radioembryology of the future will have to build a hypothesis of etiology upon the tremendous volume of descriptive teratology, substantiated in part by electron microscope analysis of the effects of ionizing radiations at the subcellular level. The final answer may reside in the chromosomes. (auth)

23327 (CONF-690501–, pp 395-406) RADIOSENSITIVITY OF THE DEVELOPING BEAGLE. Phemister, Robert D.; Garner, R. John; Tietz, William J. (Colorado State Univ., Fort Collins); Shively, James N. (Bureau of Radiological Health, Rockville, Md.).

Pregnant female beagle dogs were exposed to either 100 R of x rays or 150 R of ^{60}Co γ radiation at gestation times ranging from preimplantation stages to the early fetal period. Irradiation before implantation, on days 8, 13, 15, or 16, did not significantly increase either prenatal or neonatal mortality rates; neither were a significant number of gross malformations produced. By contrast, exposure on days 18, 19, 21, or 22 immediately after implantation and during the primitive-streak stage and early organogenesis resulted in a marked increase in both prenatal and neonatal mortality and produced a variety of major malformations. Irradiation later in embryonic development on day 25 caused no increase in neonatal mortality, but an increase in prenatal mortality was observed in litters exposed at 28 days. At 25–, 28–, and 35-day exposure times, the latter corresponding to the early fetal period, irradiated litters had an increased incidence of malformations. The $LD_{50/30}$ values for puppies exposed to ^{60}Co γ radiation during early postnatal development were relatively high, indicating that during the time shortly after birth the pups are resistant to the acute lethal effects of radiation. A period of increased radiosensitivity was then encountered at 5 to 10 weeks of age, before the animals reached adult levels of radioresistance. These findings suggest that, in its response to prenatal irradiation, the dog closely resembles the rabbit and hamster, and, in its response to early postnatal exposures, it is quite similar to mice. (auth)

23328 (CONF-690501–, pp 407-17) SUBACUTE AND LONG-TERM SURVIVAL OF RATS IRRADIATED WITH $LD_{50/30}$ X-RAY DOSES AT VARIOUS AGES. Reincke, Ursula; Stutz, Ernst; Rother, Mechthildis; Goldmann, Ehrentraud (Freiburg Univ., W. Ger.).

Noninbred Wistar rats were whole-body irradiated or sham-irradiated in eight different age groups including day 5 before birth, the day of birth, and days 2, 4, 8, 12, 24, and 96 after birth. Radiation doses, chosen to allow 50% 30-day survival of each group, varied from 220 to 700 R (or 214 to 580 rads midline tissue dose) according to variations of radiosensitivity with age. Lifetime observation started with 2609 rats that were alive at day 126 after birth. First results of this study are given as follows. The incidence of deaths between day 30 and 90 after irradiation was increased over that of sham-irradiated rats only in the groups exposed at 12, 24, and 96 days after birth. For long-term survival, age-specific mortality in irradiated groups was compared with that of sham-irradiated controls. During the first year of life, again, only in groups exposed later than 8 days after birth, increased death rates were observed. The older the age at irradiation, the greater was the monthly death rate. Repeated examinations of the estrus cycle in surviving females revealed a tendency toward estrogenic hyperactivity after radiation at day 8 or 12 and toward early menopause after irradiation at day 96. Assuming that the high acute radiosensitivity of baby rats is due to hemopoietic failure, the present findings indicate that tissues other than hemopoietic tissues clearly respond to $LD_{50/30}$ doses of radiation in a different pattern of age dependence. (auth)

23329 (CONF-690501–, pp 419-37) EFFECTS OF CONTINUOUS IRRADIATION OF MICE FROM CONCEPTION TO WEANING. Warren, S.; Gates, O. (New England Deaconess Hospital, Boston, Mass.).

Four groups of mice were compared for radiation effects: irradiation throughout pregnancy, irradiation during a 21-day neonatal suckling period, irradiation throughout pregnancy and suckling, and controls. The source of radiation, ^{60}Co, was placed intrathoracically in the mother or nurse so that the radiation was received at a relatively low rate, 7 to 120 R/day. The irradiated young and their first two generations were studied. Fertility was impaired in all groups, and some evidence of this impairment was seen in later generations. Genetic effects, only cursorily studied, were seldom seen because of the periods of observation. Life-span was shortened. Growth, as evidenced by weight, was affected more by the intensity than by the period of radiation; decrements of growth persisting in the second or third generation subsequently disappeared. Selected animals were inbred for 12 generations. Congenital abnormalities were not excessive. Leukemia incidence was within expected limits, but tumors of ovary and cancers of the breast were increased in incidence. There is no clear-cut evidence that continuous γ radiation was more effective at one perinatal period than another. (auth)

23330 (CONF-690501–, pp 439-47) PERSISTENT AND LATE EFFECTS OF WHOLE-BODY IRRADIATION IN THE JUVENILE MALE RAT. Jones, Dave C. (Naval Radiological Defense Lab., San Francisco, Calif.).

Comparison of the persistent and late effects of radiation in rats exposed as juveniles with those observed in rats exposed as adults reveals both quantitative and qualitative differences. Some quantitative differences occur among those effects that are most appropriately described as persistent. They are apparent within a few weeks after exposure and persist throughout life. The ultimate effect appears primarily related to the growth rate during the first few weeks or months postexposure. Decrements in body weight, in the consumption of food and water, and in bone growth are included in this category of effects. Other quantitative differences occur among those effects that are observable only after an appreciable latent period. The extent of these effects appears related to the de-

gree to which age-associated degenerative processes have occurred as well as to postirradiation growth and development. This group of differences is characterized by chronologic displacement of naturally occurring processes, such as mortality, degenerative changes, and tumorigenesis. Qualitative differences, such as the occurrence of particular radiation sequelae in rats exposed as adults but not in those irradiated as juveniles, or vice versa, appear to be related more specifically to the stage of development at the time of exposure. Examples of this latter category include changes in metabolic efficiency, seen only in rats irradiated as juveniles, and variations in the particular types of tumors seen late in life. (auth)

23331 (CONF-690501–, pp 449-52) RADIOSENSITIVITY OF THE IMMATURE MOUSE AS INFLUENCED BY AGE AND GENOTYPE. Nash, Donald J. (Colorado State Univ., Fort Collins).

Radiosensitivity of the immature mouse was studied in mice irradiated at 2 or 4 weeks of age. Three inbred strains of mice (C3H/He, C57BL/6, and SWR) in a complete diallele cross including inbreds and reciprocals were used. Mice were exposed to single whole-body doses of 0 to 300 R of 150-kvp x rays at 14 days of age or to 0 to 400 R at 28 days of age. Changes in gross body weight were used to assess radiosensitivity, previous studies having demonstrated that changes in body weight are an effective means of detecting differences in response to sublethal levels of irradiation. Body weights were observed at weekly intervals through 9 weeks of age. Within both age groups, weekly increases were noted following all doses, but growth rates were lessened by doses above 50 R. In general, growth-rate changes were at a maximum 1 to 2 weeks after irradiation. Although irradiated groups tended to make up some of the weight deficit, differences at the higher doses appeared to have stabilized by 9 weeks of age. Significant differences in growth rates were observed between the sexes, among the inbred strains, and between inbred and hybrid genotypes. Basic growth response following irradiation was similar in all genotypes, although some genotypic differential growth response was evidenced by significant dose × inbreds and dose × general combining ability interactions at certain weekly intervals. Growth response appeared to be similar in both age groups. (auth)

23332 (CONF-690501–, pp 453-74) EFFECT OF LOCAL IRRADIATION OF THE HEAD OF 2-DAY-OLD RATS: MORPHOLOGICAL AND FUNCTIONAL DISORDERS AND GENETIC CHANGES IN THEIR PROGENY. Savkovic, N. V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade, Yugoslavia).

The heads of 2-day-old rats were exposed to radiation doses of 100, 300, 450, or 600 R. The first part of this experiment was a study of the behavior and survival as well as of a variety of morphological changes of these animals. Whether local irradiation of the head might inhibit the development of spermatogenesis was of particular interest. Therefore, the fertility rate, histological changes of testes, and morphologic changes of sperm were followed. The second part of the investigation was oriented to the progeny of these animals through generation F_1. The results indicate that the abscopal effect of local irradiation of the head of infantile rats influenced their fertility and sperm morphology and caused histological changes of the testes. Morphological changes of the head as well as of other parts of the organism were found. Functional changes were of neurological and endocrinal origin. These animals suffered from discoordination of movements, paresis of hind extremities, tremor, microcephalia, and decreases in body weight. Malformations of the progeny in the five generations were investigitated; the results show a reduced growth rate and other changes. Related changes in the appearance of chromosomal structure in meiosis are discussed. (auth)

23333 (CONF-690501–, pp 475-86) RADIATION RESPONSE OF NEWBORN MICE AND THE EFFECT OF SHIELDING ON MORTALITY. Sundaram, K.; Bains, G. S.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Bombay, India).

Partial-body shielding during irradiation in adult animals is known to reduce the radiation mortality. However, the response of animals x-irradiated on the day of birth varies, depending upon the segment of the body shielded. Shielding of the inferior extremities resulted in initial protection as compared to the controls, but delayed deaths that resemble the well-known wasting disease, were observed. Shielding of the thymic area prevented the occurrence of these delayed deaths. There also appeared to be a critical period after birth during which such response was obtained. Data are presented to substantiate the role of the thymus in determining the pattern of response. (auth)

23334 (CONF-690501–, pp 493-510) RADIATION-INDUCED CELLULAR AND SUBCELLULAR MORPHOLOGIC ALTERATIONS IN THE DEVELOPING AND IN THE MATURE MAMMALIAN EYE. Shively, James N. (Bureau of Radiological Health, Rockville, Md.); Phemister, Robert D.; Epling, Glenwood P. (Colorado State Univ., Ft. Collins).

Morphological studies of cellular and subcellular changes showed that lesions can be induced in all ocular tissues by exposure to ionizing radiation. The information available indicates that among mature ocular tissues only the lens was demonstrated to be sensitive to exposures of less than about 1000 R. Other evidence shows that in the immature eye the maturing retina is the most sensitive ocular tissue. Severe morphologic lesions were produced by exposure to about 25 R. Relatively few subcellular morphologic studies of radioinduced alterations were made. These studies contributed mainly to a further understanding of the pathogenesis of lesions. (auth)

23335 (CONF-690501–, pp 511-15) SIGNIFICANCE OF THE STAGE OF PERINATAL DEVELOPMENT IN THE INDUCTION OF TUMORS BY A RADIOMIMETIC MULTICARCINOGEN. Vesselinovitch, S. D. (Chicago Univ., Ill.).

Radiomimetic agents encompass a variety of chemicals able to induce several biological effects that are almost identical to the changes produced by ionizing radiation. The induction of tumors at sites of action is one of these radiological phenomena. Ethyl carbamate (urethan), however, distinguishes itself from the other radiomimetic agents by having the ability to induce a broad spectrum of tumors in various animal species. An integrated series of studies in mice revealed the significance of various perinatal age periods on the inception of carcinogenesis in different organs. The rate of induction of thymic lymphoma in newborns was directly related to the immaturity of thymic cortex at the time of urethan administration. Prenatal exposure to this agent, however, failed to produce leukemogenesis. The liver, on the other hand, was prone to urethan carcinogenesis as soon as its organogenesis was completed during fetal development. Postnatally, the neoplastic potentiality of liver cells was directly associated with the growth rate of this organ. Harderian gland adenomas were most easily induced at the time of the secretory activation of these glands. Ovarian tumors and lung adenomas were readily induced both pre- and postnatally. The administration of urethan to young adults enhanced mammary gland carcinogenesis. In contrast, prenatal exposure to this agent tended to suppress and delay spontaneous tumorigenesis in this organ. It was concluded that neoplastic sensitivity varied in several tissues as they differentiated and matured. (auth)

23336 (CONF-690501–, pp 577-88) THE EFFECTS OF EXTERNAL IRRADIATION ON THE BONES OF MICE AND HUMANS OF DIFFERENT AGES. Woodard, Helen Quincy (Sloan-Kettering Inst., New York. Memorial Hospital for Cancer and Allied Diseases, New York).

Local x-ray doses of between 1440 and 2610 rads were delivered to the leg bones of mice 13 to 15 days old or 40 to 44 days old. The effects on production of alkaline phosphatase and on growth in length during the subsequent 100 days were compared. Only minor differences were found in the radiosensitivities of the bones at the two ages. Evidence is presented that suggests that osteogenic sarcoma is more likely to develop in the bones of children irradiated before the age of 6 yrs than in the bones of older children or adults irradiated with comparable doses. (auth)

23337 (CONF-690501–, pp 589-600) CONTINUOUS AND ACUTE IRRADIATION EFFECTS ON DEVELOPING ANIMALS. Hupp, E. W.; Brown, S. O.; Austin, J. W. (Texas Woman's Univ., Denton. Texas A and M Univ., College Station).

Sublethal doses of radiation in varying amounts were applied at different rates and at different stages of prenatal and postnatal development to several mammalian species. Acute sublethal γ irradiation (150 R) of male rats during the last one-third of fetal life or the first 2 days after birth produced severe atrophy of the testes and permanent sterility. Similar doses 5 to 13 days after birth also sterilized female rats. A much longer period of relatively uniform radiosensitivity, from approximately the 2nd month of prenatal life to the 2nd month of postnatal life was observed in male cattle, swine, and goats. Histological manifestations of radiation damage to the testis were similar to those observed in rats, but sterility was not produced by sublethal doses in these larger species. Sterilization of female cattle or goats with whole-body irradiation was not observed. Continuous irradiation was applied to several species for varying lengths of time during development. Doses of 1, 2, or 5 R/day for periods extending from conception to 23 days of postnatal life did not produce permanent sterility in male rats. Irradiation with 10 R/day for 30 days or with 20 R/day for 10 days beginning at the 15th day of prenatal life produced permanent sterility. Doses of 2 R/day and 7 R/day from conception to 60 days of postnatal life in goats slightly suppressed reproductivity of females but reduced sperm production to 20% of control values in the 2 R/day group and produced aspermia in the 7 R/day group. (auth)

23338 (CONF-690501–, pp 601-2) PRENATAL MANIFESTATIONS OF CONTINUOUS PRENATAL IRRADIATION. Brown, Sidney O. (Texas A and M Univ., College Station).

Female goats were exposed to 7 and 3.5 R daily of γ radiation during the gestation period to a total dose of 1043 or 521 R. From the 18 females receiving 7 R daily, 12 male and seven female irradiated offspring were obtained. From the animals receiving 3.5 R approximately the same number of offspring were produced. None of the offspring showed any externally visible anomalies, and all were in good health with no marked differences between the irradiated groups and the controls. (H.L.W.)

23339 (CONF-690501–, pp 603-12) EFFECT OF AGE AT EXPOSURE ON THE BONE-MARROW STEM-CELL POPULATION IN RELATION TO 30-DAY MORTALITY IN MICE. Proukakis, C.; Coggle, J. E.; Lindop, Patricia J. (Medical College of St. Bartholomew's Hospital, London).

The survival probability of a mammal irradiated with a dose inducing hemopoietic death is a function of the absolute number of surviving stem cells. The $LD_{50/30\ days}$ is age dependent in the mouse. The age dependence might be due to an age dependence of the radiosensitivity of stem cells, or to a combination of both. Studies on the total bone-marrow cellularity and the colony-forming-unit (CFU) content of bone marrow have been carried out in mice 4 to 150 weeks old. The results indicate that the number of stem cells is age independent in the mouse. The radiosensitivity, however, of the CFU is age dependent; there is a good agreement between this and the $LD_{50/30}$ in all the age groups studied, except the very old mice. In this group, the $LD_{50/30}$ is lower than might be expected on the basis of the radiosensitivity of CFU. The possible reasons for this discrepancy are discussed. The validity of the conclusion that the number of stem cells is age independent in the mouse was further tested in two age groups, 6 and 30 weeks old, which have very different, nearly extreme, values of $LD_{50/30}$. Two different doses, 700 and 900 rads, inducing the same fractional survival of CFU, that is 10^{-3}, were given to large numbers of mice. The 30-day lethality was approximately 80% in both groups. This indicates that the total number of stem cells is similar in those two age groups. (auth)

23340 (CONF-690501–, pp 613-20) EFFECTS OF GAMMA RADIATION ON ORGANOGENESIS IN THE PRENATAL BOVINE. Erickson, B. H.; Reynolds, R. A. (UT-AEC Agricultural Lab., Oak Ridge, Tenn.).

To test the effects of radiation administered at high intensity on organogenesis in the bovine, 54 pregnant heifers were exposed to a 350-R air dose of γ radiation at 50 R/min (170 rads to embryos). At least five heifers were irradiated on each of the odd-numbered days from day 15 (blastocyst) to day 33 (end of major organogenesis). With the exception of days 15 and 17, one embryo from each exposure age was recovered 2 days postirradiation and prepared for histological analysis. Following irradiation at day 33, embryos were recovered at 2, 3, 8, 17, and 27 days postirradiation to follow histologically the development of a defective thoracic limb. Development of embryos recovered 2 days after irradiation was retarded by at least 24 hr as revealed by gross and microscopic evaluations. Little evidence of cellular necrosis was apparent prior to day 25, but, from this point to day 33, numerous necrotic cells were noted within the neural tube and surrounding mesenchyme. Birth weights of calves were apparently unaffected by radiation administered prior to day 23, but, from day 25 to day 33, weights decreased as age at irradiation increased (55% of control, day 33). Viability was reduced at day 23 (two of four embryos survived), reached a minimum at day 27 (no survival), and increased thereafter. However, with the exception of one 29-day-old calf, calves irradiated at days 29, 31, and 33 were euthanized due to severe limb defects. Embryos irradiated prior to day 19 developed normally, but each of two calves irradiated at day 19 had a defective eye, and one of these was also hydrocephalic. Two other day-19 calves were apparently normal. The 21- and 23-day calves were unaffected; with exception of the day-29 calf noted, all embryos irradiated at or between day 25 and day 33 developed either no limbs or defective limbs. Routine pathological examinations revealed no other defects. (auth)

23341 (CONF-690501–, pp 637-47) RADIATION EFFECTS ON DEVELOPING EMBRYOS AND FETUSES. Casarett, George W. (Rochester Univ., N. Y.).

Some of the salient features of prior knowledge and of papers presented at this conference are summarized. Emphasis is placed on radiation exposure during the period from late fetal life to puberty. Early effects on acute lethality and syndromes, the central nervous system, gonads and fertility, and pathology of bone growth are reviewed. Late effects on life span, body weight, food consumption, and bone growth are discussed. (H.L.W.)

23342 (CONF-690501–, pp 739-54) EFFECTS OF REGIONAL IRRADIATION OR ABLATION OF THE INFANT RAT CEREBELLUM ON MOTOR DEVELOPMENT. Hicks, S. P.; D'Amato, C. J.; Klein, S. J.; Austin, L. L.; French, B. C. (Michigan Univ., Ann Arbor).

The cerebellums of infant rats were x-irradiated in various ways or surgically ablated, and the developing motor function of the animals was observed to maturity and recorded in slow-motion movies. Adult animals were also cerebellectomized for comparison. Malformation of the cerebellar cortex and folia resulted in disturbance of coordination of locomotor movements. The effectiveness of the malformation in disturbing function paralleled the anatomic extent of the abnormality and the dose that produced it. A part of the cerebellum malformed by 400 R had more effect on function than the whole cerebellum malformed by 200 R. Ablation of part of the cerebellar cortex and folia in infancy did not appreciably alter motor development. However, if the fastigial nuclei were ablated, the animals were severely and permanently incapacitated; they had difficulty in standing up or moving more than a few steps without falling. They could drag themselves about and eat and drink. Adult animals cerebellectomized were at first completely incapacitated, but they showed some recovery in a period of weeks. (auth)

23343 (CONF-690501–, pp 755-67) MECHANISMS FOR THE DIFFERENTIAL RADIOSENSITIVITY OF IMMATURE BRAIN TISSUE: DEVELOPMENT OF HYDROCEPHALUS AND ALLIED CONDITIONS. Murakami, Ujihiro; Hoshino, Kiyoshi; Kameyama, Yoshiro (Nagoya Univ., Japan).

Mice of the ddN–JCL strain were exposed to a single dose of 200 or 300 R of x irradiation between days 7 and 12 of pregnancy, and the fetuses were observed on day 18. Other groups of mice were irradiated with 200 R between days 7 and 11, and the effects were studied from histologic sections of embryos removed from 2 to 24 hr after x irradiation. Other embryos were examined at daily intervals until day 18. Elevated incidence of hydrocephalus occurred twice. The first peak followed exposure on day 9, and the second peak followed exposure on day 11. Microcephalic specimens were also found; histologic examinations showed them to be hydromicrocephalus. In mice exposed on day 9 or 10, a part of the mesencephalon, the anterior part of the prosencephalon or telencephalon, the optic anlagen, rhombencephalon, spinal cord, etc., were selectively involved. In those treated on day 11, the telencephalon and the optic anlagen were especially vulnerable. Two hr after exposure, necrosis of the neural elements was marked. Such involvement was very intense; the brain mantle became very thin, broken, and partially lost. However, repair of such involved parts proceeded until 24 hr after the exposure, forming rosettes. This process was different in relation to the developmental stage exposed. Rosette formation seemed closely connected to the formation of hydrocephalus and hydromicrocephalus, which are classified as dysgenetic hydrocephalus. The observed hydromicrocephalus is not comparable to human microcephalus because of ionizing radiation of the cerebrum. In contrast, microcephalus was also found in a very recent experiment using Wistar rats. (auth)

23344 (CONF-690501–, pp 769-77) DIFFERENTIAL VULNERABILITY TO IRRADIATION OF VARIOUS CEREBRAL STRUCTURES DURING PRENATAL DEVELOPMENT. Dekaban, Anatole S. (National Inst. of Health, Bethesda, Md.).

Twelve groups of pregnant mice were x-irradiated daily with 200 R from the 7th to the 18th day of gestation. Cesarean-section deliveries were performed on the 19th day of gestation in all animals. Histological sections were prepared from four levels of the brain and examined microscopically. Various types of malformations and other lesions were scored semiquantitatively. Main attention was directed to the distribution of lesions in cerebral structures of different phylogenetic derivation. The true or organ-type malformations (dysraphism and single ventricle brain) were encountered following irradiation on the 8th and 9th gestation days. Following irradiation between the 9th and 17th days of gestation, the abnormalities consisted of foci or parenchymal degeneration, regenerative heterotopias, and, finally, minor cortical imperfections. The least sensitive to irradiation during this stage were structures of paleopallium (prepyriform and enthorhinal areas and olfactory bulbs); the diencephalic structures were moderately sensitive, the archipallium (hippocampus) was considerably more sensitive, and the neopallium exhibited the greatest sensitivity to irradiation of all brain subdivisions. (auth)

23345 (CONF-690501–, pp 779-97) ANALYSIS OF SPLIT-DOSE EFFECTS ON CEREBRAL HEMISPHERE: CELL RECOVERY FOLLOWING X IRRADIATION OF THE FETAL BRAIN. Brizzee, K. R. (Tulane Univ., Covington, La.); D'Agostino, A. N. (Texas Univ., Houston); Bench, C. J.; Jacobs, L. A. (Utah Univ., Salt Lake City).

Ultrastructural studies demonstrated tissue recovery in fetal

CNS following whole-body x irradiation with 130 R on gestation day 13. Split-dose studies in fetal rat brains were initiated for further study of cell recovery following x irradiation. One group of pregnant albino rats received single whole-body doses of x radiation of from 12.5 to 200 R on gestation day 13. A second group received an initial dose of 100 R on gestation day 13 followed, after an interval of 9 hr, by a second dose of from 12.5 to 125 R in increments of 12.5 R. Both groups were sacrificed on gestation day 19. The increase in severity of teratological effects in olfactory lobes and cerebral hemispheres was relatively small between doses of 12.5 and 87.5 R in the single-dose series and between 12.5 and 50 R in the split-dose group. At higher doses the residual damage increased rapidly in both groups. A semilog plot of mean depth of cortical plate of the fetal brains as a function of radiation dose level in the single-dose group revealed a shoulder zone between doses of 12.5 and 62.5 R and an exponential limb of the dose-response curve between 75 and 200 R. A semilog plot of mean depth of cortical plate in the split-dose group revealed a shoulder zone between second doses of 12.5 and 50 R and an exponential limb of the dose-response curve between second doses of 62.5 and 125 R. The presence of a shoulder zone on the second dose-response curve in the split-dose group suggests that cell recovery in fetal brain tissues may occur, in some degree, following exposure to x irradiation. (auth)

23346 (CONF-690501–, pp 877-86) CHROMATOGRAPHIC ANALYSIS OF THE LIPIDS OF BEAGLE PUP BRAIN EXPOSED IN VIVO TO X RADIATION. Manes, J. D.; Chiacchierini, R. P.; Youmans, H. D. (Bureau of Radiological Health, Rockville, Md.).

Prior to 1958, children were epilated by x irradiation as part of the treatment for tinea capitis, a fungal infection of the scalp. Irradiation of the central nervous system has been reported to cause demyelination. A pilot study in this laboratory with 1-yr-old beagles indicated that both lipid and morphological changes might occur at the 200-rad level. A study was therefore conducted to measure changes in brain lipid fractions and in morphology which might result from tineal x-ray exposures. Four litters with a total of 13 beagle pups were studied. Eight were given a head-only exposure to 500 R of 100-kVp x rays. The average brain dose was 215 rads, as determined with a mix-D beagle skull phantom and LiF dosimeters. Five pups were sham-irradiated as controls. The sacrifice schedule extended from 1 day to 9 months after exposure. Thin-layer chromatography, quantitated by densitometry, was used to measure six lipid fractions; histopathological examinations were also performed. Lipid composition changes were observed in the cerebrum of the irradiated animals and were found to vary as a function of time postirradiation. (auth)

23347 (CONF-690501–, pp 913-16) DEVELOPMENTAL RADIOBIOLOGY. Hicks, S. P. (Univ. of Michigan, Ann Arbor).

The width and breadth of the field of developmental radiobiology in relation to the nervous system is considered in relation to the results of studies now being made. Cell killing, morphologic and sometimes functional alterations in differentiation, biochemical studies on radiation effects on brain enzymes, and the role of dose rate and developmental stage in radiation effects on neural cells are topics that were discussed. (C.O.)

23348 (CONF-690501–, pp 943-54) EFFECT OF HORMONAL ENVIRONMENT ON THE RADIOSENSITIVITY OF OOCYTES. Beaumont, Heather M. (Birmingham Univ., England).

This experiment was undertaken to see if changes in the hormonal environment affect the sensitivity of oocytes in the adult rat. One ovary of hypophysectomized and unoperated (or intact) female rats was exposed to x radiation doses of 105, 315, and 420 R; the unexposed ovary served as control. Other groups of operated and intact females were given 10 iu of pregnant-mare serum gonadotrophin (PMS) on the 3 days preceeding irradiation. Animals were killed either 24 hr or 7 days after exposure, and the numbers of oocytes in irradiated and control ovaries were subsequently counted and compared. The results of this study show that: fewer oocytes are lost from the ovaries of hypophysectomized rats than from those of unoperated animals given an equal dose of radiation; exogenous gonadotrophin administered to operated animals at the time of irradiation reverses the effect of hypophysectomy (it may render the primordial oocytes even more radiosensitive than those in the intact animal); exogenous gonadotrophin administered to unoperated animals slightly increases the resistance of primordial oocytes. These findings are discussed and related to observations on the radiosensitivity of oocytes in animals exposed before puberty. (auth)

23349 (CONF-690501–, pp 975-84) IRRADIATION AND ENZYME ONTOGENESIS IN THE RAT AND BEAGLE. Garner, R. J.; Graves, Juanita P.; Lane, C. E. (Colorado State Univ., Fort Collins).

The effect of prenatal γ irradiation on enzyme ontogenesis was examined using as test systems glycerolphosphate dehydrogenase in rat and beagle liver and brain, nonspecific esterases in rat liver and brain, and serine dehydratase in rat liver. Evidence is presented for a differential effect of radiation in terms of specific enzymes and stage of development at exposure. It is suggested that the apparent stimulation by early in utero exposure of the postnatal increase in activity of brain enzymes reflects over-recovery from early inhibition. The elevated postnatal hepatic serine dehydratase activity observed following irradiation of the early conceptus or of the ovum prior to fertilization cannot be explained on this basis. (auth)

23350 (CONF-690501–, pp 985-94) IMPAIRED INCORPORATION OF LABELED PHENYLALANINE INTO PROTEIN IN THE X-IRRADIATED FETAL RAT. Shore, M. L.; Laskey, J. W.; Simmons, L. R.; Jessup, G. L. Jr. (Bureau of Radiological Health, Rockville, Md.).

Morphological and biochemical alterations produced by irradiation during fetal development were investigated by numerous workers. Although morphological changes were documented during gestation, most studies on biochemical processes, particularly protein and enzyme synthesis, were performed after the birth of fetally irradiated animals. This study examines the effect of fetal irradiation on fetal incorporation of labeled phenylalanine into protein. Sprague–Dawley rats were irradiated in utero (180 rads, 250 kVcp x rays delivered to pregnant mothers on day 13 of gestation). Incorporation of ^{14}C-labeled phenylalanine into protein was measured 24 hr postirradiation. Both in vivo incorporation of labeled amino acid into protein and in vitro incorporation by a cell-free system were examined. Radiation produced a significant decrease in incorporation both in vivo and in vitro. (auth)

23351 (CONF-690501–, pp 995-1000) HOW X RAYS BLOCK LIMB REGENERATION IN SALAMANDERS AND A METHOD FOR REINSTATING REGENERATION. Rose, S. Meryl (Tulane Univ., New Orleans, La.).

Evidence that limb regeneration fails in salamanders after x irradiation because nerves fail to make proper contacts with the epidermis is reviewed. This failure to make proper contacts results in a failure of the flow of information between cells. X-rayed cells are capable of regeneration and take an active part in it if the communication system is restored by grafts of normal tissue. (auth)

23352 (CONF-690501–, pp 1001-11) EFFECTS OF X RAYS ON THE DIFFERENTIATION OF GASTRULAS OF AMPHIBIANS AND ON THE DIFFERENTIATION OF THE FEATHER GERMS IN THE SKIN OF CHICKEN EMBRYOS. Reyss-Brion, M. (College de France, Paris).

X irradiations of the ectoderm of young gastrulas of amphibians and of the skin of chick embryos show that the tissues that are differentiating are very radiosensitive but that the inductor tissues are able to support very strong doses of x rays. Autoradiographic and biochemical studies point out a fall in the DNA synthesis in the tissues after irradiation. (auth)

23353 (CONF-690501–, pp 1013-15) DEVELOPMENTAL RADIOBIOLOGY. Sikov, Melvin R. (Battelle Memorial Inst., Richland, Wash.).

Knowledge from data and results available from studies in radiation biology of the fetal and juvenile mammal in 1953 and 1969 are contrasted. The conceptual advances made over the years are pointed out in relation to studies on cross-placental transfer of radioisotopes, the metabolism of inorganic elements by the neonatal organism, factors influencing the response of perinatal animals to radiation, long-term effects of radiation on the intrauterine or neonatal animal, the effect of continuous and fractionated doses of irradiation, quantitative effects of radiation as measured by biochemical techniques (content of DNA in a cell rather than cell weight), and the physiological and biochemical changes that result from irradiation. It was concluded that recent advances in technique and concept should accelerate the trend toward a more complete understanding of the mechanisms and processes of normal development. (C.O.)

23354 (COO–1024-35) A COMPARISON OF THE CYTOLOGICAL EFFECTS PRODUCED BY IONIZING RADIATIONS OF DIFFERENT LET. Technical Progress Report. (Iowa Univ., Iowa City. Radiation Research Lab.). Mar 1970. Contract AT(11-1)-1024. 20p. Dep. CFSTI.

Studies were conducted on cell labeling index as a function of repeated pulse labeling with ^{3}H-TdR. Following pulse labeling of rat lens epithelial cells, autoradiographs of whole mounts were prepared and percentages of cells in different phases of the cell cycle were calculated. It was concluded that there was no distinct subpopulation of G_0 cells that could be distinguished from a cell cycle subpopulation of cells. Mice were used for studies on the

influence of hyperbaric oxygen conditions on the cataractogenic effectiveness and x radiation. Mice were exposed to single doses of 400 to 1200 rad and fractionated doses totaling 1000, 1100, or 1200 rad. At each dose level irradiation in hyperbaric oxygen was more cataractogenic than irradiation in air. Only 70% of the fractionated dose was effective; the lens had recovered from 30% of the first two doses during the intervals between doses. Wound response was used to study latent radiation damage and cellular recovery in the intermitotic cells of the rat lens epithelium. Tritiated thymidine was used to study the wave of DNA synthesis evoked by the wounding. It was found that DNA synthesis spreads outward from the wound and increases in amount up to 18 hrs after wounding. The wave of mitotic activity began about 24 hrs after wounding, reached a maximum at 28 to 30 hrs, and then began to subside. Electron microscope studies were begun on the mouse lens capsule and epithelial cells. (H.L.W.)

23355 (COO-1024-40) COMPARISON OF THE CYTOLOGICAL EFFECTS PRODUCED BY IONIZING RADIATIONS OF DIFFERENT LET. Nine Year Summary. [Riley, E. F.] (Iowa Univ., Iowa City. Radiation Research Lab.). Mar 1970. Contract AT(11-1)-1024. 10p. Dep. CFSTI.

Tritium-labeled thymidine was administered to rats for studies on DNA synthesis in the lens epithelium. Three types of cell populations in the lens eipithelium are characterized. Nine months after administering 1000 rad of x rays to the lens eipithelium there was a conspicuous depletion of the cell population in the peripheral region and all cell populations were disorganized. Studies on the effects of x radiation on wound response in the lens epithelium showed that there was a latent radiation damage in the intermitotic cells and cellular recovery from this damage occurred. Hyperbaric oxygen conditions appeared to enhance the effectiveness of x radiation. Application of dimethylsulfoxide did not prevent cataractogenic effects of x radiation. Dimethylsulfoxide and x radiation in combination caused a vascularization of the cornea in many cases. Effects of radiation on visual function of the human eye were observed following radiotherapy in the region of the eye. (H.L.W.)

23356 (UR-49-1254) SOME EFFECTS ON MAMMALIAN DEVELOPMENT OF CONTINUOUS IRRADIATION IN UTERO WITH TRITIATED WATER. Cahill, Daniel Francis (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1970. 86p. Dep. CFSTI.

Nuclear reactor-effluent and fuel reprocessing waste streams containing elevated levels of tritium activity are confluent with rivers providing part or all of the residential water supplies in some areas. Most of the tritium released is in the form of tritiated water (HTO) which is rapidly and uniformly distributed in body fluids. Since the body water of a pregnant female is in equilibrium with the HTO activity prevailing in the local environment, the embryo and fetus, the most radiosensitive phases of life, develop in an aqueous environment which provides continuous irradiation of its total body. As an adjunct the embryo and fetus incorporate tritium as a substitute for hydrogen into its organs and tissues during development. To investigate the consequences of continuous, in utero exposure to HTO, groups of 12 to 17 Sprague-Dawley rats were maintained at body water levels of 0, 1, 10, 20, 50, 75 and 100 μCi/ml HTO through pregnancy. The initial maternal body burdens were established on the day of positive sperm determination by intraperitoneal injection of high specific activity HTO. Body water HTO levels were then maintained at a constant level during pregnancy by providing HTO in drinking water supplies. These HTO activities provided irradiation at 0.3 to 30 rads/day to the embryo and fetus during development. Term fetuses were removed by Caesarean section 21 days after positive sperm and postnatal observations were made on litters born naturally. HTO administration was terminated on the day of delivery. Regardless of the exposure level all progeny were grossly normal with respect to external and internal morphology. Statistically significant litter size reduction associated with increased resorption occurred only at the highest dose level. Stunting of the term fetuses, as evidenced by significant decreases in weight and length occurred at 20 to 100 μCi/ml whereas no effect on these parameters was noted at 10 μCi/ml and a significant increase in length was observed after exposure to 1 μCi/ml. Significant decreases in the absolute weights of a number of irradiated term fetus organs were closely proportional to dose. Significant reductions in the relative weights of the gonads and brains were noted at doses of 10 to 100 μCi/ml; in the spleen at 20 to 100 μCi/ml; in the heart, kidney and thymus at 50 to 100 μCi/ml. No weight reductions were noted in the liver and lungs at any dose level. No organ weight reductions occurred after exposure to 1 μCi/ml HTO but increases were noted in the heart and liver. Histologically, all organs were normal except the gonads. Measurements of irradiated term fetus brains in combination with the reduced relative weights indicated that microencephaly, in the rat, can be induced by exposure to as little as 10 to 20 μCi/ml HTO during pregnancy. Tritium analyses of dried fetal organs showed incorporation to be directly proportional to, and 20 to 30% of, the maternal body water HTO activity prevailing during development. Recovery from initial weight and length deficits of 20 to 100 μCi/ml females occurred by 90 days but deficits persisted in the 50 to 100 μCi/ml males through the end of observation at 180 days. By 90 days most organs had attained control relative weight values except the 20 to 100 series gonads, female brains in the 50 to 100 series and the kidneys of both sexes at 100 μCi/ml. Sterility was present in both sexes exposed in utero to 50 to 100 μCi/ml HTO. The relative radiosensitivities of term fetal organs to continuous irradiation were: gonads > brain > spleen > thymus > kidney > heart. With the exception of a significant increase in liver weight at 1 μCi/ml there was no apparent effect on the lungs and liver. Comparison of the results of these HTO irradiations with the effects of continuous, external gamma irradiation during pregnancy in the rat showed that an RBE of 1.7 was necessary to equate the results. Continuous exposure to 1 μCi/ml HTO during pregnancy in the rat was found to be consistent with the production of offspring in which the only deviations from controls noted were an increase in length and slight hyperplasia of the liver and heart. Subject to the limitations inherent in assuming an equivalence of the rat and human fetus, 1 μCi/ml HTO is 200 times greater than the maximum continuous exposure recommended by the ICRP for members of the public living in the vicinity of a controlled (radiation) area. (auth)

23357 EFFECTS OF X-RAYS ON THE THYMUS GLAND IN MICE. I. STUDY OF THE DIFFERENT RADIO-SENSITIVITY OF THE LYMPHOCYTES OF THE CORTICAL AND MEDULLARY REGION. Gibertini, Giancarlo (Univ., Rome). Riv. Biol., 60: Suppl., 3-37(1967). (In Italian and English).

The effect of irradiation (450 R single exposure) on the cortical and medullary lymphocytes of the thymus was studied and four phases in the response of this gland to the action of x rays were analysed. The death in situ of the lymphocytes was discussed, and in relation to their different sizes, a different percentage of mortality among the small and the large lymphocytes was found. The radiosensitivity of the lymphocytes in the cortical region differed from that in the medullary portion and theories to explain this phenomenon were formulated. The first regeneration period of the thymus was followed, and a comparison was made between the cortical and medullary parts. An increase in the volume of the Hassall corpuscles, probably in relation to the period of more intense lymphocytic destruction, was noted. (auth)

23358 CONCOMITANT LOSS OF SPECIFIC CELL-SURFACE ANTIGEN AND DEMONSTRABLE TYPE-C VIRUS PARTICLES IN LYMPHOMAS INDUCED BY RADIATION LEUKEMIA VIRUS IN RATS. Ferrer, Jorge F.; Gibbs, Frederic A. Jr. (Stanford Univ., Calif.). J. Nat. Cancer Inst.; 43: 1317-30(Dec 1969).

Examined were the antigenic properties and content of type-C virus particles of a series of lymphomas induced by radiation leukemia virus (RadLV) in Wistar Furth (W/Fu) inbred rats. In conformity with previous studies, adult syngeneic rats ordinarily reject these tumors unless these recipients are irradiated. Evidence indicates that this rejection involves an immunologic mechanism elicited by a new transplantation antigen shared by different RadLV-induced lymphomas of W/Fu rats. All lymphomas rejected by adult syngeneic hosts had high concentrations of the RadLV cell-surface antigen, as revealed by in vitro cytotoxic and absorption tests. The concentration of this antigen was lower in a few tumors able to grow in nonirradiated adult hosts. Electron microscopy of leukemic tissues and plasma of rats with either primary or transplanted syngeneic lymphomas showed type-C virus particles in concentrations markedly higher than those previously observed in RadLV-induced lymphomas of mice. Progressive growth of 3 RadLV-induced lymphomas in rats preimmunized with the same tumor occasionally was observed. In contrast to the original lymphoma lines, sublines isolated from these outgrowths could be maintained by serial transplantation in nonirradiated adult W/Fu rats, and they were not susceptible to the rejection response of specifically preimmunized rats. They were also fully resistant to the specific cytotoxicity of RadLV antisera. After serial passage in nonirradiated recipients, in vitro absorption experiments indicated an apparently complete loss of the RadLV antigen. Extensive electron microscopic examination of the RadLV lymphoma sublines indicated that virus particles were either absent or radically decreased in concentration as compared to the original lines. One of these sublines, tested after 3 consecutive passages in preirradiated hosts, had no restoration of the antigen. (auth)

23359 WOUND HEALING FOLLOWING TOOTH EXTRACTION. I. HISTOLOGICAL STUDIES ON THE HEALING OF EXTRACTION WOUNDS IN TISSUE INJURED BY RADIATION. Schuele, H.;

Ludwig, F. (Univ., Erlangen, Ger.). Deut. Zahn-, Mund-Kieferheilk.; 51: 5-22(Jul 1968). (In German).

Effects of preirradiation of the mouth with 4000 to 6000 R doses of x irradiation given in 1000 R doses 3 or 4 days apart, 3 months before tooth extraction, was studied in dogs. In the preirradiated alveoli there were two different courses of healing. In the animals that received a dose of 4000 R the course of healing was much delayed. This delay was apparent in development of the granulation tissue in the marginal zone and the center, the collagenous connective tissue in the marginal zone, the small osteoid trabeculae in the fundus and the alveolar margins, and the ossifying centers in the alveolus. Epithelial proliferation of the alveoli was not altered much. The involution of the gingival borders was sparse, and because the surface of the coagulum was larger, epithelialization was relatively delayed. In the animals that had received 6000 R the coagulum that had formed disintegrated and osteoradionecrosis developed. Following disintegration of the coagulum, necrosis of the internal alveolar corticalis appeared. The osteoradionecrosis involved the alveolar process to various degrees. There was no macroscopic or microscopic evidence of demarcation or reparative processes in the osteoradionecroses 35 days after tooth extraction. (BBB)

23360 ACTION OF X RAYS ON OVULATION IN CHICKEN. Brard, E. (College de France, Paris). Arch. Anat. Histol. Embryol. Norm. Exp.; 51: 99-105(1968). (In French).

The effects of single doses of 600 or 900 R, repeated to give total doses of 1800 to 2400 R, of x rays on ovulation in the chicken were studied. In 42 pullets the number of eggs laid after the various treatments was compared. The irradiated pullets produced an average of 20.3 eggs compared to 19.4 in the controls, indicating that irradiation did not inhibit ovulation. The possible slight stimulating effect of irradiation observed here has been demonstrated in other species also. In particular, there was a significant increase in eggs laid 1 month after a single 600-R dose. Only very high doses (5400 R) caused an inhibition of ovulation. The possibility of ovulation stimulation being mediated by the pituitary glands via gonadotropin hypersecretion is discussed, as well as the possible correlation between radioinduced destruction of some oocytes and enhanced development of surviving follicles. (BBB)

23361 RADIOBIOLOGIC STUDIES ON MICE EXPOSED TO HIGH-ENERGY BREMSSTRAHLUNG OF 3 GeV. Zywietz, Friedrich; Kuenkel, Hans A.; Staehler, Fritz (Univ., Hamburg). Strahlentherapie; 138: 709-13(Dec 1969). (In German).

NMRI-mice were exposed to whole-body irradiation of 3-GeV-bremsstrahlung with doses from 200 to 1300 Rad at the Hamburg electron synchrotron (DESY). Dosimetry was carried out by means of ionization chambers, a ferrosulfate dosimeter, and of a quantimeter. The mortality of the animals was observed within 30 days after irradiation. The action of the high-energy radiation on the erythropoiesis was examined by means of the radioiron-utilization test. In all experiments the high-energy radiation was less effective than equal doses of 200 keV x-rays. From dose-effect curves the RBE was calculated to about 0.8. (auth)

23362 STUDIES ON THE RBE OF 14 MeV NEUTRONS IN LABORATORY ANIMALS AND HeLa CELLS. Graul, Emil Heinz; Ruether, Walter; Krueger, Helmut (Philipps-Univ., Marburg, Ger.). Strahlentherapie; 138: 699-708(Dec 1969). (In German).

Extensive physical and dosimetric measurements were done with the neutron beam before the biological experiments designed for the determination of RBE-values. Dosimetry was done by activation of $MgCl_2$-solutions with an overall accuracy of ±7.5%. Following RBE values were obtained: LD 50 at 30 days for mice, rats and guinea pigs: 2; weight loss in rats, mice and guinea pigs: 2 to 3; weight reduction of the intestine in rats and guinea pigs: 2.5 to 3; induction of cataract in rabbits: 2 to 5; mitotic inhibition in HeLa cells: 2.5. (auth)

23363 THE PHOTO-OPHTHALMIC THRESHOLD FOR THE RABBIT. Pitts, Donald G. (AF School of Aerospace Medicine, Brooks Air Force Base, Tex.); Kay, Kenneth R. Amer. J. Optom.; 46: 561-72(Aug. 1969).

A forced transpiration arc source was used to produce high intensity ultraviolet radiation. Using argon gas, the source produced a spectrum from 180 nm to 2.5 μ. Calibration and monitoring techniques were described. The different uv wavebands were obtained using a nickel-sulfate, cobalt-sulfate liquid filter cell and a B & L 500 mm grating monochromator. The photokeratitis thresholds obtained for rabbits were consistently lower than published values. Predictions were made for keratitis thresholds for man in outer space. (auth)

23364 EFFECTS OF PATERNAL X-IRRADIATION ON LITTER SIZE AND EARLY POSTNATAL MORTALITY IN SWINE. Mullaney, P. D.; Cox, D. F. (Ames Lab., Iowa). Contract AT(11-1)-707. Mutat. Res.; 9: 337-40(Mar 1970).

Data were collected from 3053 litters of pigs of Duroc and Hampshire breeds raised in Iowa between 1960 and 1966. One male of each pair of full brothers was exposed to 300 R of x radiation, and males were mated to pairs of full sisters about five months after irradiation. The average litter size and the proportion of young pigs dead in each period are tabulated. X irradiation of the Duroc sires significantly increased the litter size by about 0.4 pigs and slightly increased the mortality in these litters. There were no significant effects of sire irradiation on litter size in the Hampshire breed. However, the incidence of stillbirths was significantly decreased in the Hampshire litters, following maternal grandsire irradiation. In general, inconsistent and very few detectable effects of maternal grandsire irradiation were noted. (H.L.W.)

23365 EFFECT OF IRRADIATION ON RENAL ENLARGEMENT FOLLOWING UNINEPHRECTOMY IN THE RABBIT. Caldwell, W. L.; Hattori, H.; Rhamy, R. K. (Vanderbilt Univ., Nashville). J. Urol.; 103: 399-402(Apr 1970).

Following unilateral nephrectomy, acute irradiation (1,600 rads) of the remaining kidney results in an increased enlargement (58 per cent) over that seen in non-irradiated kidneys of control uninephrectomized rabbits (40 per cent). A similar phenomenon is not seen if irradiation precedes nephrectomy. Possible explanations for this finding are discussed. (auth)

23366 EFFECTS OF URANIUM ON RABBIT RENAL TUBULES. Bowman, Faye J.; Foulkes, E. C. (Univ. of Cincinnati). Toxicol. Appl. Pharmacol.; 16: 391-9(1970).

Following an earlier report of effects of uranium on proximal tubules in rabbit kidney, the present results define lesions caused by intravenous administration of 0.2 mg of uranium per kilogram of body weight on functions of more distal portions of the nephron. Depression of free-water clearance during water diuresis, decreased water conservation during hydropenia, and dissipation of the normally high tissue sodium concentration in the renal medulla all point to inhibition of sodium reabsorption from the ascending limb of Henle's loop. More distally, effects are seen on sodium and water reabsorption under stop-flow conditions. On the other hand, distal potassium secretion, as well as the normal impermeability of collecting duct epithelium to urea in the absence of ADH, remain unaffected. Damage to the nephron clearly occurs beyond the proximal tubule, previously believed to be the major site of attack of uranium on the rabbit nephron. (auth)

23367 THE GROWTH, REPRODUCTION, LONGEVITY, AND HISTOPATHOLOGY OF RATS FED GAMMA-IRRADIATED CARROTS. Tinsley, Ian J.; Bone, Jesse F.; Bubl, Edward C. (Oregon State Univ., Corvallis). Toxicol. Appl. Pharmacol.; 16: 306-17(1970).

Carrots irradiated to 2.79 megarad and 5.58 megarad with gamma rays were fed as 35% of the total ration solids to rats over a period of two years and through three generations. The performance of animals raised on these rations was compared with that of animals raised on a ration containing a similar proportion of unirradiated carrots. Except for a small but significant depression in growth rate, no deleterious effects were observed that could be attributed to the irradiation. This growth depression was not observed consistently in subsequent experiments. Poorer food efficiencies were observed with rations containing carrots irradiated to 2.79 megarad, and it is suggested that this level of irradiation may not be adequate to arrest deterioration of the carrots. Carotene in the irradiated carrot rations was not used as efficiently for storage of vitamin A in liver. The ingestion of irradiated carrots did not influence longevity or reproductive performance, nor did it produce any consistent detrimental changes in histopathology or hematology. It is concluded that no toxic hazard is associated with the ingestion of carrots irradiated to 5.58 megarad provided that the level of irradiation is sufficient to inhibit natural deteriorative processes. (auth)

23368 FURTHER STUDIES ON THE REPLICATION OF THE LACTATE DEHYDROGENASE-ELEVATING VIRUS (LDH VIRUS) IN MOUSE PERITONEAL MACROPHAGE CULTURES. Evans, R. (London Hospital Medical Coll. Sloan Kettering Inst. for Cancer Research, Rye, N. Y.). Proc. Soc. Exp. Biol. Med.; 133: 831-6 (Mar 1970).

The response of day-old peritoneal macrophage cultures from whole-body x-irradiated (600 R) mice to inoculation with a standard dose of LDH virus, 10^6 ID_{50}/ml, was consistent in all experiments; peak virus infectivity up to 10^9 ID_{50}/ml was reached by three days followed by a decline to below the ID_{50} within 21 days. Cultures were not infected by doses of virus containing less than 10^3 ID_{50}/ml. Since lymphocytes were shown not to be involved in the replicative process, and interferon could not be detected in the supernatant

fluids of infected cultures, it is suggested that the decline in virus infectivity might be caused by the combined effect of the exhaustion of a small number of susceptible cells and an age-dependent decrease in susceptibility of macrophage cultures. (C.H.)

23369 EFFECT OF X IRRADIATION ON THE MANDIBULAR CONDYLE. Furstman, Lawrence L. (Univ. of Southern California, Los Angeles). J. Dent. Res.; 49: 419-27(Mar-Apr 1970).

Changes in the cartilaginous layers of the condyle and in the calcifying matrix, in osteoblastic and osteoclastic activity, loss of primary trabeculae and hematopoietic elements of the marrow, plus a loss of vascularity and a decrease in size, were observed. Recovery after exposure to 600 R total body radiation was also observed. (auth)

23370 DATA FOR HYGIENIC STANDARDIZATION OF NATURAL URANIUM IN WATER. Novikov, Yu. V.; Yudina, T. V. (Moscow Research Inst. of Sanitation). Gig. Sanit.; No. 1, 54-61(Jan 1970). (In Russian).

Dynamic investigations of kidney function during chronic enteral uranium administration in small concentrations showed no significant changes in the content of urea, creatine, and chlorides in the blood serum of experimental animals in comparison with control ones. The activity of alkaline phosphatase of the blood serum increased in the 11th month of uranium poisoning at concentrations of 6 to 60 mg/l. A rise in the acid phosphatase activity was noted in the spleen homogenate of rabbits that received uranium in concentrations amounting to 50 MPC (maximum permissible concentrations) of the substance. In case of chronic enteral action of uranium in concentrations of 50 and 100 MPC, nucleic acid metabolism was inhibited in the kidneys and the liver. (auth)

23371 SIGNIFICANCE OF "ADRENALINE TEST" FOR ESTIMATION OF INDIVIDUAL SENSITIVENESS OF ANIMALS TO X-IRRADIATION. Madievskii, Yu. M.; Khil'ko, A. S. (Pedagogical Inst., Kharkov). Fiziol. Zh., Akad. Nauk Ukr. RSR; 16: 96-102 (Jan-Feb 1970). (In Ukrainian).

Changes in the peripheral blood leukocyte count in rats after injecting 0.25 mg of adrenalin per kg of body-weight (adrenalin test) were studied in connection with the relation of this value and the leukopenia level after x irradiation. There was a real correlation between an increase in the amount of leukocytes in adrenalin test and the rapidity of recovery of leukocyte content in rats exposed to 50 to 700 R total irradiation. After exposing to 1200 R all the animals died and the aforementioned correlation did not take place. The mean lifetime of rats irradiated by 500 to 700 R was also closely connected with previous adrenalin test values of the same animals. (auth)

23372 EFFECT OF LOCAL AND GENERAL ANESTHESIA ON THE STATE OF ACTIVITY OF CHOLINESTERASE AND BLOOD ELECTROLYTES IN COMBINED RADIATION INJURY. Aripov, U. A.; Borukhov, S. A.; Ryazantsev, V. A. Eksp. Khir. Anesteziol.; 14: 63-6(May-Jun 1969). (In Russian).

The authors took 61 healthy and 76 acutely irradiated rabbits (800 R) to test the influence of local anesthesia with 0.25% of novacain solution and endotracheal anethesia on thigh amputation and the activity of the whole blood cholinesterase, potassium component in plasma and erythrocytes, and plasma calcium at one hr and 24 hr after anesthesia and surgery. Every trauma inflicted (surgery, radiation) caused significant redistribution of electrolytes between the blood fluid and the formed elements, as witnessed by a marked decrease of potassium content in plasma and its increase in the erythrocytes. After radiation sickness and local anesthesia, the level of cholinesterase activity decreased insignificantly. Electrolyte balance of plasma was practically the same. Potassium content in the erythrocytes rose. Radiation trauma deteriorated the course of intubation anesthesia. A method of choice after combined radiation trauma is local anesthesia. (auth)

23373 FUNCTIONAL STABILITY OF ELECTRO-MECHANICAL COUPLING OF STRIATED MUSCLE FIBRES. Zhukov, E. K.; Ul'yanitskaya, A. E. (Inst. of Evolutionary Physiology and Biochemistry, Leningrad). Fiziol. Zh. SSSR; 55: 563-8(May 1969). (In Russian).

Studies have been made on the effect of ionizing radiation upon the electro-mechanical coupling in skeletal muscle fibers of the frog, Rana temporaria. It was demonstrated that in doses of 35 to 40 krad the amplitude of contractions of sartorius muscles evoked by direct electrical stimulation decreased in spite of the increased action potentials. Action potentials began to decrease only at doses 50 to 60 krad. Exposure to muscles depolarized by potassium ions to irradiation doses of 35 to 40 krad decreased the membrane potential level still more, the decrease in the membrane potential of muscle fibers being accompanied by decrease in the amplitude of contractures. Exposure of muscles to 35 to 40 krad did not affect the amplitude of their caffeine contractors, which decreased only after exposure of muscles to doses of 70 krads and higher. On the basis of data obtained, it was concluded that of the three functional sites of a muscle fiber, its superficial membrane, electro-mechanical coupling, and contractile system, electro-mechanical coupling exhibited the lowest resistance to the injurious effect of ionizing radiation. (auth)

23374 MORPHOLOGICAL PICTURE OF INJURIES AND RESTORATIVE PROCESSES IN THE COMBINED EFFECT OF EXTERNAL AND INTERNAL IRRADIATION. Lavrent'ev, L. N. (Research Inst. of Radiation Protection, Leningrad). Med. Radiol.; 15: No. 3, 76-8(Mar 1970). (In Russian).

Combined external (with 300 R x rays) and internal irradiation with mixtures of ^{90}Sr and ^{144}Ce was studied with 350 male rats. Data showed combined injuries inherent to each type of irradiation. Moreover, combined exposure slowed up recovery processes, especially, with doses inducing deep injuries. (R.V.J.)

23375 INFLUENCE OF GAMMA-RADIATION ON THE DEVELOPMENT OF THE SKELETON OF EXTREMITIES OF MICE EMBRYOS. Neverova, L. G. (First Leningrad Inst. of Medicine). Med. Radiol.; 15: No. 1, 57-9(Jan 1970). (In Russian).

The features peculiar to the action of relatively large and small doses of ^{60}Co γ radiation on the development of the bones of the extremities of 247 mice embryos are discussed. The action of a dose of 300 rad in the phase of high sensitivity of the embryonal extremity caused severe monstrosities. Irradiation to lower doses (100 to 50 rad) led mainly to an inhibition of ossification. The irradiation effect depended upon the dose of radiation and the stage of development of the embryo. (auth)

23376 SPONTANEOUS THYROIDITIS IN THE OBESE STRAIN OF CHICKENS. V. THE EFFECT OF SUBLETHAL TOTAL BODY X-IRRADIATION ON THE DEVELOPMENT OF THE DISEASE. Wick, Georg; Kite, Joseph H. Jr.; Witebsky, Ernest (State Univ. of New York, Buffalo). J. Immunol.; 104: 344-52 (Feb 1970).

The effect of neonatal sublethal total-body x irradiation on the development of chronic thyroiditis in chickens of an obese strain (OS), the Cornell C strain, and a normal strain of White Leghorns was studied histologically and serologically. At the time of death, seven weeks after hatching and irradiation, a significant increase in severity and frequency of chronic thyroiditis was observed in both the OS and C strain chickens; thyroiditis was also found in more than half of the irradiated normal White Leghorn chickens. In all three strains under investigation the histologic findings correlated well with the presence of circulating antibodies to thyroglobulin (hemagglutinating and precipitating) in the sera of most of the diseased birds. Irradiation damage to the thyroid glands or to the immune system is discussed from the standpoint of single or combined factors that cause an increase in the severity and frequency of thyroiditis after neonatal x-irradiation of chickens. (auth)

23377 EFFECTS OF SMALL DOSES OF IONIZING RADIATION. Rossi, Harald H. (Columbia Univ., New York). Phys. Med. Biol.; 15: 255-62(Apr 1970).

Energy deposition in cells exposed to ionizing radiation occurs through the agency of individual charged particles. At low doses the number of these particles is of the order of 1. One may then expect comparatively simple inactivation dynamics, and, in particular, the relative biological effectiveness (RBE) should become a simple function of the absorbed dose of either of the radiations under comparison. Experimental data on the dose dependence of RBE are limited but the results of three such studies are consistent with the assumption that the dose-effect relation is linear for neutrons of high LET (energies of the order of 1 Mev) and quadratic for x- and γ-rays. (auth) (UK)

23378 HEMOGLOBIN SYNTHESIS IN MICE AFTER BONE MARROW TRANSPLANTATION. Basch, Ross S. (New York Univ. Medical Center, N. Y.). Proc. Soc. Exp. Biol. Med.; 133: 865-9(Mar 1970).

The hemoglobins synthesized in the spleen and bone marrow of whole-body sublethally x-irradiated mice protected by the transfusion of isogenic bone marrow were studied under a variety of circumstances. Only adult hemoglobin synthesis was observed during the period of observation. The results are consistent with the evidence that the hemoglobins found in the fetal mouse are of extraembryonic origin and therefore are phylogenetically related to the human Gower hemoglobins and not hemoglobin F. (auth)

Man

Refer also to abstracts 23125, 23126, 23221, 23222, 23225, 23227, 23242, 23243, 23273–23275, 23278, 23281, 23283, 23291, and 23407.

23379 (CONF-690501–, pp 651-9) ANALYSIS OF THE MORBIDITY AND MORTALITY OF CHILDREN IRRADIATED IN FETAL LIFE (II). Griem, M. L.; Mewissen, D. J.; Meier, P.; Dobben, G. D. (Chicago Univ., Ill.).

In 1948, 1008 mothers who were to bear their first child had diagnostic pelvimetry early in pregnancy. In 1947 and 1949, routine pelvimetry was not used. The x-ray dose from this equipment was measured, and the absorbed dose in the fetus was between 1.5 and 3 rads. The morbidity and mortality of these three groups were compared by mail and telephone contacts. The data were coded using the International Classification of Diseases. It was previously reported that there was no evidence of difference in the incidence of leukemia in the three groups. There was an increase in the number of hemangiomas observed in those children who were irradiated in utero, and a number of other observations were made. Subsequent to the initial report in 1967, a second contact was made with the subjects involved. These data were prepared for computer analysis. These findings are reviewed and discussed in detail. (auth)

23380 (CONF-690501–, pp 661-73) THE EFFECTS OF FALLOUT RADIATION ON MARSHALLESE CHILDREN. Sutow, Wataru W. (Texas Univ., Houston); Conard, Robert A. (Brookhaven National Lab., Upton, N. Y.).

In March 1954, 82 people of Rongelap Island in the Marshall Islands were accidentally exposed to sublethal doses of fallout radiation during the atomic bomb testing program. Of these people, 64 received about 175 rads of whole-body γ-ray exposure and 18 received about 69 rads. Additional radiation exposure occurred from radioactive material deposited on the skin and hair and from ingested radionuclides. This report summarizes the medical findings in the exposed children over a 15-year period as compared with findings in the adults. (auth)

23381 (CONF-690501–, pp 675-80) THE AGE FACTOR IN RADIATION CARCINOGENESIS OF THE HUMAN THYROID. Sampson, Richard J.; Key, Charles R.; Buncher, C. Ralph; Iijima, Soichi (Hiroshima Univ., Japan).

Five hundred and thirty-six thyroid carcinomas (518 occult papillary) were found in 3067 consecutive autopsies in Hiroshima and Nagasaki from the JNIH-ABCC Life Span Study. Most of the prevalence is not related to radiation, but there is a significantly greater prevalence in those exposed to 50 rad or more of direct radiation at the time of the atomic bombs. Analysis by age indicates that in those 46 years old or older at the time of exposure there is a significantly ($p < 0.02$) greater prevalence of thyroid carcinoma in those exposed to 50 rad or more than in those exposed to zero rad. Those 20 years old or younger showed a similar association, but, presumably because of the small number of cases, the difference did not reach significance ($p < 0.41$). There was no indication that dose–prevalence relations differed between the youngest and oldest age groups. The mean size of papillary carcinomas decreased in the females but not in the males with increasing age at death. This suggests that there may be age-related differences in factors promoting the growth of papillary carcinoma of the thyroid. (auth)

23382 (CONF-690501–, pp 681-92) RADIOGENIC CANCERS OF CHILDHOOD. Stewart, A. M. (Oxford Univ., Eng.).

In a continuous series of 6347 juvenile cancers, it was estimated that there were between 370 and 390 radiogenic cases, or children, who died as a result of being exposed to diagnostic x rays shortly before birth. The estimates are based partly on comparisons between x-rayed and non-x-rayed cases. The former showed that about 6% of the cases in every diagnostic group were radiogenic; and the latter, that the radiogenic and nonradiogenic cases had different age distributions. On the assumption that there are neither clinical nor histological differences between radiogenic and nonradiogenic cancers, it was further estimated that a month or two before birth (i.e., the usual date for being x rayed in utero) is a relatively late date for a cancer to start if it is going to cause death before the age of 10 years, and that over 70% of cancers in this age range are the results of lesions that predate birth. The age distributions of the radiogenic cases show that intervals between inception dates and onset dates (i.e., latent periods) depend on the nature of the cells involved in the neoplastic process. They also show that these intervals are rarely shorter than 2 yr and may be too long to be measured accurately in a survey confined to children under 10 yr of age at death. (auth)

23383 (CONF-690501–, pp 693-717) EVIDENCE FOR LOW-LEVEL RADIATION EFFECTS ON THE HUMAN EMBRYO AND FETUS. Sternglass, E. J. (Pittsburgh Univ., Pa.).

Evidence is presented that indicates a high sensitivity of the developing human embryo and fetus to both acute x radiation diagnostic levels and low dose-rate radiation from fallout. The effect expresses itself by increased rates of childhood leukemia accompanied by a shift in age distribution at death, as well as by increased rates of stillbirths, neonatal deaths, and infant deaths in large population groups that have been exposed to known amounts of low-level fallout. The earliest evidence for low-level and low-dose-rate effects was obtained from a detailed analysis of the leukemia increase among children 0 to 10 years old in the Albany–Troy, N. Y., area following the rainout of radioactive debris from a 43-kt nuclear detonation in Nevada in April 1953. The subsequent doubling of the childhood leukemia rate over a period of 8 yr was characterized by a 4- to 5-yr delay in onset similar to that observed for children who received x radiation in utero or early infancy and a shift in age distribution at onset toward older age similar to that noted by Stewart and Hewitt for intrauterine x irradiation. More recent evidence for the effects of low-dose and low-dose-rate radiation on the developing fetus, embryo, and young infant comes from a study of fetal, neonatal, and postnatal mortality rates for each state in the United States and for a number of foreign countries. Analysis of the changes in mortality rates following the detonation of specific nuclear weapons shows a geographical distribution that coincides with the known long-range fallout patterns. The changes in mortality rates for different regions of the United States and the world are found to be closely correlated with the measured amounts of ^{90}Sr in the milk and the observed amounts in the bone and teeth of the fetus and newborn. (auth)

23384 (CONF-690501–, pp 719-29) HUMAN EFFECTS OF LOW-LEVEL RADIATION: A CRITIQUE. Sagan, L. A. (Palo Alto Clinic, Calif.).

A critique of two separate but related studies of fallout radiation effects, leukemia incidence in certain counties of New York and neonatal mortality in several states and Western Europe, is presented. Problems with the analysis of data that are discussed were quality of the original data, reference to cases by year of report rather than by year of onset of diseases or by year of birth, no consideration of influence of diagnostic in utero irradiation, no consideration of leukemia experience elsewhere in New York, reporting of cases and not rates, effectiveness of radiation dose resulting from fallout of 1953, and presumptions related to neonatal mortality. In relation to the methodology used in the studies, the lack of use of biostatistical tests of significance, use of cases in deference to rates, lack of controls, and assumption of causal relations between simultaneous events were cited as flaws. The critique was concluded with the statement that more persuasive evidence than that offered by these studies is needed to build a case for fallout effect. (C.O.)

23385 (CONF-690501–, pp 731-5) RADIATION EFFECTS ON MAN. Bibb, W. R. (Division of Biology and Medicine (AEC), Washington, D. C.).

The exposure of man to radiation from natural or man-made sources is discussed. The natural sources that were very briefly mentioned were cosmic rays and radiation emitted by radioactive materials in the ground, air, and structures in which man lives and works. The man-made sources discussed were diagnostic and therapeutic use of x rays, fallout, and radioactive wastes. Problems inherent in the establishment of guidelines to balance the biological risk and the potential benefit of man-made radiation are then considered in relation to studies that should be made on the biological effects of radiation on man. The studies mentioned included diseases that occur following radiation exposure and chemical and biological factors affecting radiation effects on man. (C.O.)

23386 CHANGES IN KIDNEY UNDER THE ACTION OF IONIZING RADIATION (A REVIEW OF THE LITERATURE). Kurshakov, N. A.; Kireev, P. M.; Gasteva, G. N. Klin. Med. (Moscow), 45: 22-5(July 1967). (In Russian).

Dystrophic changes in glomeruli and channels of the kidneys were observed following the administration of uranium or polonium to animals. Disturbances in filtration, reabsorption, channel secretions and loss in concentrating ability were observed in dogs given polonium. A number of cases involving kidney malfunction were noted following irradiating the peritoneal cavity for cancer treatment. Protein was often detected in the urine. The functional state of the kidneys was studied in patients suffering from radiation sickness. Decreases in blood flow and glomerular filtration were noted. The morphological changes in kidneys due to uranium are summarized. (TTT)

23387 POST-MASTECTOMY IRRADIATION LINKED TO VISCERAL METASTASES. J. Amer. Med. Ass.; 211: 1776(16 Mar 1970).

A retrospective study on 56 patients with breast cancer, most of whom had radical mastectomies, treated with mediastinal, supraclavicular, and axillary ^{60}Co γ or x radiation, showed that the total

peripheral lymphocyte count in all patients was greatly reduced for two or more years compared with pre-treatment levels. Forty-seven patients that did not receive post-mastectomy radiation therapy showed only slight variation in lymphocyte counts. A possible relation between radioinduced thymo-lymphocyte immune deficiency, increased visceral metastases, and decreased response to hormone therapy is discussed. (C.H.)

23388 BIRTH DEFECTS IN CHILD OF MALE RECIPIENT OF KIDNEY TRANSPLANT. Tallent, Marion B.; Simmons, Richard L.; Najarian, John S. (Univ. of Minnesota, Minneapolis). J. Amer. Med. Ass.; 211: 1854-5(16 Mar 1970).

A case is reported of birth defects in a child sired by a male recipient of a kidney transplant who had received three courses of local irradiation totaling 1,350 rads to the graft five years previously. A possible teratogenic effect of ionizing radiation on the male gonads is discussed. (C.H.)

23389 THE CLINICAL PICTURE AND DIAGNOSIS OF RADIATION INJURY OF THE SPINAL CORD IN THE TREATMENT OF MALIGNANT TUMORS. Kozlova, A. V.; Merkova, M. A. (Research Inst. of Radiology, Moscow). Med. Radiol.; 15: No. 2, 7-12(Feb 1970). (In Russian).

Ten cases of radiation injury of the spinal cord after irradiation of tumors of the pharyngolarynx, larynx, tonsils, mediastinum, and lung are described. In five patients electric paresthesia developed several months after radiotherapy without objective symptoms of spinal pathology. In seven years one patient developed a focal affection of the spinal cord with slowly progressing symptoms. In five patients with cancer of the laryngopharynx progressive affection of the spinal cord resulted in a lethal outcome. In four of them the focus of spinal affection was first revealed at 3 to 6 segments below the irradiated level and symptoms of affection of irradiated segments of the spinal cord only appeared gradually. An analysis demonstrated that in contrast to metastatic affection, radiation injury develops more slowly, with gradual spread of the process lengthwise and crosswise in the spinal cord; for metastases extramedullary localization is more characteristic, whereas radiation injury always runs a course of intramedullary process. The prevention of late radiation injuries consists in the choice of conditions of irradiation of malignant tumors in which the spinal cord is excluded from the zone of large doses. (auth)

23390 THE STATE OF PERIPHERAL CIRCULATION IN RADIOTHERAPY. Vasil'eva, E. I.; Sheshina, G. A. (Central Research Inst. of Radiology, Moscow). Med. Radiol.; 15: No. 2, 17-23(Feb. 1970). (In Russian).

The state of the peripheral circulation in radiotherapy was studied in 83 patients with malignant neoplasms; in 59 of them the heart was within the zone of irradiation. It was found that in irradiation of the region of the heart and remote areas of the body there occurred hemodynamic shifts characterized by alteration of the arterial pressure, elasticity of arterial vessels, modules of resistance, systolic and minute blood volume, and peripheral resistance. In a number of cases hemodynamic indexes declined, as the result of which the state of circulation was maintained on an average level. However, the adaptation reaction was not always noted, as the result of which there was a disturbed concordance in the work of the heart and vessels. There was found signs of myocardial dystrophy and disorder of coronary circulation, thus deteriorating the state of the hemodynamics. Disorder of the peripheral circulation in radiotherapy should be considered not only from the viewpoint of vascular insufficiency. Apparently disturbance of the neurohumoral apparatus regulating the circulation is of paramount importance. (auth)

23391 PULMONARY REACTIONS TO RADIATION ASSOCIATED WITH ^{60}Co RADIOTHERAPY OF LUNG CANCER. Kanno, Iwao; Ito, Yasuhiko (Tohoku Univ., Sendai). Kosankinbyo Kenkyu Zasshi; 20: 397-410(Dec 1968). (In Japanese).

A study was made of the pulmonary reactions to γ radiotherapy with ^{60}Co in 100 cases of primary lung cancer. The patients received a daily dose of 250 to 400 R six times a week, the total tumor dose of 5,000 to 6,000 R. Pulmonary disorders were observed in 39 cases starting at 1,000 R (19%) with a rapid increase around 3,000 R (31%) until it reached the maximum at 8,000 R (50%). The incidence of leukopenia became marked with the tumor dose of 3,000 R (12%), gradually increased in parallel with the increase in tumor dose, reaching the highest with 7,000 to 8,000 R (22%). The incidence of pulmonary disorders paralleled the decrease in leukocyte numbers, although it was 25 to 35% higher. Pulmonary disorders were classified into three stages according to the radiographic findings. The results indicated that the degree of pathological changes of the lung were not necessarily in proportion to tumor dose but more likely influenced by the radiosensitivity of the individuals. The follow-up study suggested that prognosis depended upon the preirradiation state of the patients. (NSA of Japan)

23392 RADIATION HAZARDS. Steel, J. Ind. Saf.; 16: 64-6(Feb 1970).

A brief review is given of the nature, sources, effects and control of "man-made" radiation. Radiations considered include ionizing radiation, uv, visible, infra-red, laser and radio. (UK)

23393 EVALUATION OF RISKS FROM LATE SOMATIC EFFECTS. Mole, R. H. (Medical Research Council, Harwell, Eng.). Atomkernenergie; 15: 64-7(1970).

The delayed harmful effects that have actually occurred in irradiated human beings are briefly outlined and contrasted with the endpoints commonly employed in experimental investigations of late effects of radiation. The ideas that radiation causes ageing and that life-shortening is an appropriate parameter for theoretical and experimental study are criticized. If generalizations based on experimental work are to be applicable to man, they must incorporate means of making quantitative allowances for differences in radiosensitivity and other biological properties between species. (auth)

Radiation Effects on Plants

Refer also to abstracts 23162, 23165, 23169–23172, 23175–23177, and 23407.

23394 (ORO-2412-27) THE EFFECTS OF FLASHING GAMMA RADIATION ON SEEDS OF WHEAT, TRITICUM VULGARE L. Wilson, Lawrence A. (Emory Univ., Atlanta, Ga.). 1969. 234p. Dep. CFSTI.

Thesis.

This study compared the effects of ultrafractionated and constant ^{137}Cs γ radiation dose accumulation on the seeds of wheat, Triticum vulgare L., as determined by the inhibition of elongation in the coleoptile, shoot, and roots of germinating seedlings, during the initial three days of growth. A variable speed rotating device, utilizing a replaceable lead ingot design, was fabricated so as to allow the ultrafractionation of dose in the specified manner. Three levels of dose, 0 kR, 12 kR and 24 kR; three levels of flash interval, .015 seconds, 0.15 seconds, and 1.5 seconds; and five ratios of flash to nonflash fraction, 0/4, 1/4, 2/4, 3/4, and 4/4, were used as the basic experimental matrix or independent variables. A single genetic strain of hexaploid wheat was used with pre- and post-irradiation environment, degree of hydration, seed age, and physical and chemical state held constant. Logistic curve fits were derived for all data as the most appropriate summation of the structural growth of each dependent variable. Using an analysis of variance, the contribution of each independent variable was measured against the three basic parameters of each logistic curve, these being the values of X, Y, and slope at the curve symmetry point. A similar analysis was performed on the predicted 48 and 72 hour length values, as interpolated from the appropriate curve. An expected dose effect was found, but it was not significantly different for the constant and ultrafractionated methods of dose accumulation. Several additional parameters such as dose rate, fraction/interval relationship, time versus distance interaction, biomagnetic effect, seed handling and seed degradation were statistically evaluated. No parameter, other than dose, was found to have consistently affected the dependent variables of the test matrix at significant levels. Some histological and histochemical results were also examined for evidence of differential effects due to method of dose accumulation. Only a total dose effect was found on specific mitotic and epidermal structures. (auth)

23395 (ORO-2976-21) GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES. Progress Report, May 1, 1969–April 30, 1970. Burton, Glenn W.; Powell, Jerrel B. (Georgia Univ., Tifton. Georgia Coastal Plain Experiment Station). Contract AT(40-1)-2976. 57p. Dep. CFSTI.

The effect of thermal neutron seed irradiation on the forage yields of three pearl millet (Pennisetum typhoides) genotypes was determined. Results showed that irradiation did not significantly increase the forage yields of any one of the three genotypes and irradiation of millet seeds with 19,200 R significantly reduced the forage yield of the average millet 5.3% below the yield of the control. (auth)

23396 INFLUENCE OF GAMMA-RADIATION ON SOME CHARACTERS AND PROPERTIES OF THE BROAD BEAN,

Vlk, J.; Janovec, Z. (Univ. of Agriculture, Prague). Genet. Slechteni; 5: 193-8(Sep 1969). (In Czech).

The effects of γ radiation on the broad bean, Lehmanns Weender variety, showed that an acute or a chronic effect for 6, 12, or 24 hr at doses of 500, 1,000, 3,000, 5,000, 7,000, 9,000, or 11,000 R reduced the germination. The number of fertile plants exhibited a marked decline from 3 to 5 kR. With higher doses the number of plants damaged as a result of irradiation of the seed increased. They lagged behind in growth and development, died away, or proved sterile. If the apical point was injured, the plant was able to activate the growth of the branches from the established secondary apical points. This ability appeared especially when radiation was applied for 6 hr. A segregation ratio 3:1 for the occurrence of hard seeds was proven statistically. The segregating strains amounted to up to 35%. (auth)

23397 METHODS FOR ACCELERATED DETERMINATION OF THE RADIOBIOLOGICAL EFFECT AT IRRADIATION OF PLANT SEEDS. Kavats, G. E.; Roze, K.; Taranova, E.; Bakis, E. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis; No. 12, 51-7(1969). (In Russian).

Several methods for preliminary forecasting of radiation effect upon the survival, fertility, and yield of plants were tested. It was established that the seed germination and the height of seedlings could not serve as a criterion for forecasting the said indexes in irradiated plants. For practical purposes in conditions of Latvia, the Osborne and Lunden laboratory method for plant survival prognosis can be applied. It was shown that with certain modifications the said method could be used also for forecasting of fertility and yield of irradiated plants as well as that the prognosis could be made on the basis of initial field data. (auth)

23398 RADIOBIOLOGICAL MEASUREMENTS WITH ^{252}Cf. Hall, Eric J. (Columbia Univ., New York); Fairchild, Ralph G. Brit. J. Radiol.; 43: 263-6(Apr 1970).

Seedlings of Vicia faba were used as a radiobiological test system to measure the OER for protracted low dose-rate exposures to radium γ rays, and to the mixed neutron γ-ray emission from ^{252}Cf. For radium at a dose-rate of 46.9 rads/hour the OER was found to be 2.02; for californium at a dose-rate of 16.02 rads/hour the OER was 1.66. The lowering of OER which would result from replacing radium with ^{252}Cf for interstitial and intracavitary radiotherapy techniques would be less dramatic than the change of OER that would result from replacing telecobalt units with 14 MeV neutron generators for beam therapy. (auth) (UK)

23399 SURVIVAL OF CHLORELLA UPON CONTINUOUS CULTIVATION AFTER A SINGLE γ-IRRADIATION. Sakovich, I. S.; Vekshina, L. K. Kos. Biol. Med.; 3: 24-7(May-Jun 1969). (In Russian).

A study was made of the relationship between the survival of Chlorella upon continuous cultivation and the dose of γ irradiation. The cultivation was performed using methods of regular suspension dilution and microcolonies. A comparison of the results obtained by the two methods suggests that changes in the yield of irradiated Chlorella are chiefly associated with the damage of its genetic and cytoplasmic structures, the photosynthetic activity remaining unaltered. (auth)

23400 OXYGEN EFFECT FOLLOWING NEUTRON IRRADIATION OF DRY BARLEY SEEDS. Conger, B. V.; Constantin, M. J. (Univ. of Tennessee, Knoxville). Radiat. Bot.; 10: 95-7(Feb 1970).

It was shown that oxygen can modify the response of dry seeds to neutron radiation although to a lesser extent than that for x or γ radiation. It was considered that this effect was due to the difference in the linear energy transfer of neutron and γ radiations. It was suggested that the ability to observe the effect through post-irradiation soaking was dependent on the irradiation of seeds in the absence of oxygen. (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 23119, 23120, 23164, 23173, and 23368.

23401 (BARC-451) INVESTIGATIONS ON BASIC MECHANISMS OF RADIOSENSITISATION BY CHEMICALS. [PART] III. Singh, B. B.; Srinivasan, V. T.; Bhatt, B. Y.; Joshi, D. S.; Shenoy, M. A.; Bedekar, V. W. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 32p. Dep. CFSTI (U. S. Sales Only).

Sensitization of bacteria to radiation by vitamin K_5, its analogues, and iodoacetic acid is caused by short-lived transients of sensitizers. These short-lived transients are produced by reactions of sensitizers with hydroxyl radicals. Sulphydryl poisons that sensitize cells exert their effects by different mechanisms. The radiosensitization is further enhanced by using electron scavengers. During sensitization by iodoacetic acid, membrane proteins are iodinated in all amino acid residues; this affects many biochemical processes regulated by membrane enzymes. The sensitization is therefore believed to be attributable to total protein poisoning of cells. (auth)

23402 ON THE ORNITHINYL ESTER OF PHOSPHATIDYLGLYCEROL OF MYCOBACTERIUM 607. Khuller, G. K.; Subrahmanyam, D. (National Inst. of Communicable Diseases, Delhi). J. Bacteriol.; 101: 654-6(Feb 1970).

Ornithinyl ester of phosphatidyl glycerol accumulated in Mycobacterium 607 under acidic conditions (pH 5.6) of growth or in cultures of uv-irradiated (320 to 420 nm) bacilli. There was a corresponding decrease in cardiolipin content of the organisms under these conditions. (auth)

23403 THE ACTION OF SENDAI VIRUS INACTIVATED BY ULTRAVIOLET LIGHT ON RNA SYNTHESIS IN EHRLICH ASCITES CELLS. Botis, S.; Vladimirtseva, E. A.; Bukrinskaya, A. G. (St. S. Nicoiau Inst. of Inframicrobiology, Bucharest). Rev. Roum. Inframicrobiol.; 5: 237-43(1968).

Infection of ascites cells with purified Sendai virus at a high input multiplicity (1000 to 25,000 EID_{50}/cell) inhibited all the cellular RNA fractions. To demonstrate that this inhibition of cellular RNA synthesis is linked to the infectivity of the active virion or its structural components, comparative studies were carried out concerning the action of infective and noninfective virus, inactivated by uv light, on cellular RNA synthesis. Virus was irradiated with a PRK-4 lamp, at a distance of 20 cm, for 20, 40, 60, 80, 100, and 120 sec. After uv irradiation the virus was titered in embryonated eggs to assess infectivity. The uv-inactivated virus inhibited ribosomal RNA synthesis, just as the active virus, and, in contrast to the latter, stimulated the synthesis of messenger RNA (27S). In actinomycin-treated cells, 27S RNA synthesis was completely blocked and the synthesis of all the cellular RNA fractions was inhibited. It was concluded that inhibition of cellular RNA synthesis, following the inoculation of Sendai virus into Ehrlich ascites cells at a high input multiplicity, is related especially to the structural components of the viral particles. (BBB)

23404 RESISTANCE OF STAPHYLOCOCCUS AUREUS TO DESICCATION HEAT AND ULTRAVIOLET RAYS IN RELATION TO PHAGE PATTERN. Iwasawa, Yoshio; Ishihara, Keizo (Gunma Univ., Maebashi, Japan). Jap. J. Microbiol.; 11: 305-9(Dec 1967).

The effects of drying, heating, and uv irradiation on differential death rates of different strains of staphylococci were studied. The 128 strains of Staphylococcus aureus used were obtained from patients with staphylococcal infections in surgical clinics. Cell suspensions were irradiated with uv rays at 2650 Å by a Matsuda germicidal lamp for 80 min at a distance of 3 m. Staphylococci of phage group I including type 81, particularly type 80/81, showed significantly high death rates after desiccation, dry heating, and wet heating, and significantly low death rates after uv irradiation. In contrast, group-II strains responded inversely to these physical agents. The mean death rate of group-III strains approximated that of group I after desiccation, dry heating, and uv irradiation, but after wet heating it was lower than that of group II. The results indicated that transmissibility of staphylococci might be influenced to a great extent by physical factors in the environment outside the body. (BBB)

23405 INTERACTION BETWEEN THE LIGHT EMITTING SYSTEM AND METABOLISM IN LUMINOUS BACTERIA. Rase, S. (Justus Liebig-Univ., Giessen, Ger.). Biophysik, 6: 173-89(1969). (In German).

Reaction kinetics of the light-emitting system of luminous bacteria (Achromobacter fischeri) in vivo show different behavior from that observed in in vitro systems because of the participation of the system in the metabolism of the bacterial cell. Changes in the process of light production through physical or chemical influence (external or internal) should be investigated in connection with the total metabolic scheme. Anoxia at different ages of the bacterial population and reaeration after a period of time causes more or less damped oscillating adjustment of the disturbed equilibrium. Irradiation with uv-light affects this system directly, and indirectly through the nutritious environment, but only in the presence of oxygen. The results are discussed with respect to the concept that the luminous system is a bypass in metabolism. (auth)

23406 SENSITIVITY OF THE RIGHT AND LEFT FORMS OF BACILLUS MYCOIDES FLUEGGE TO UV IRRADIATION. Kasinova, G. V.; Kasinov, V. B. (Leningrad Inst. of Physics and Tech.). Mikrobiologiya; 38: 1062-7(Nov-Dec 1969). (In Russian).

Various forms of Bacillus mycoides of the same parent genotype exhibit different sensitivity to uv. The cultures with thin long threads (T+L) are more sensitive to uv irradiation than cultures with short threads. The cultures lacking threads have a different sensitivity to uv, similar to that of the parent cultures. Changed sensitivity to uv is not strictly connected with the modification of morphological properties of the colonies. (auth)

23407 CHANGES OCCURRING IN THE COMPOSITION OF THE VAGINAL BACTERIAL FLORA ACCOMPANYING TRICHOMONAS VAGINALIS IN WOMEN TREATED WITH γ- AND X-RAYS. Slowakiewicz, Emilia; Zawadzki, Jerzy; Halys, Josef. Wiad. Parazytol.; 15: 449-51(1969). (In Polish).

In the course of investigations on the behavior of Trichomonas vaginalis under the effect of ionizing rays (γ and x rays) in women treated for neoplastic changes in the organ of generation, changes in the vaginal bacterial flora were observed. Altogether 81 cases were examined and 243 bacteriological examinations were carried out. The vaginal flora was determined in preparations made directly after collecting the material and in culture on artificial mediums. Moreover, the sensitivity of the isolated strains to basic antibiotics was determined. The results obtained showed a considerable increase in the quantity of bacteria of the genera Escherichia, Proteus, Streptococcus and Staphylococcus positive coagulase. Microorganisms of the genera Candida and Staphylococcus negative coagulase occurred in small numbers. The changes observed in the bacteriological picture of the vagina are presumably brought about by the action of ionizing rays by products formed during the disintegration of neoplastic cells. (auth)

23408 INHIBITION BY CHLOROQUINE OF UV REPAIR IN E. COLI B. Yielding, K. Lemone; Yielding, Louise; Gaudin, David (Univ. of Alabama, Birmingham). Proc. Soc. Exp. Biol. Med.; 133: 999-1001(Mar 1970).

The 4-aminoquinoline, chloroquine, has been shown to decrease survival of E. coli B when placed in the plating medium after uv irradiation, and to inhibit dark repair or liquid holding repair of uv damage in cell suspensions. This and similar drugs should prove useful in elucidating the mechanism and biological role of mutation repair. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 22849, 22865, 22878, 22902–22907, 23116, 23188, and 23367.

23409 (BARC-455) STUDIES ON WHOLESOMENESS TESTING OF GAMMA-IRRADIATED WHEAT. Aravindakshan, M.; Vakil, U. K.; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 109p. Dep. CFSTI (U. S. Sales Only).

Irradiation procedures for food preservation were studied with respect to quality of the processed products. This included effects on nutritive value and on the possible induction of toxic or carcinogenic substances or of radioactive nuclides, besides microbiological safety. Studies on a variety of irradiated foods were reviewed. Stored wheat was successfully freed of insect infestation by doses in the range of 20 Krads of γ-rays. Such disinfestation has advantages over conventional fumigation practices in that all species of grain pests as well as their eggs could be eliminated; unlike fumigants, repeated treatment was not necessary so long as reinfestation was prevented by suitable storage practices. In experiments with rats and mice, fed for five generations on adequate diets containing 75% wheat, unirradiated or irradiated at 20 and 200 Krads, it was demonstrated that there are no differences in growth and food utilization between the different groups. Specific organ weights as well as hematological, biochemical, and histological data did not indicate any detrimental effects from the feeding of wheat irradiated even at 10 times the required dose levels. No reproductive impairments due to these diets were observed. Lactation, longevity, as well as tissue function were also investigated. Similar studies with mice, in five generations and up to two matings in each were also included. A short-term feeding study with weanling rats fed for 12–15 weeks on irradiated (20 and 200 Krads) complete diets, based on prevailing dietary pattern of low income groups, showed that, compared to the unirradiated diet, there were no adverse effects on growth, food efficiency and other parameters studied, such as hematological data and organ weights. (auth)

23410 (EUR-4417) STUDY OF THE CHANGES IN THE CONSTITUENTS OF IRRADIATED FLOUR BY MEANS OF SPECTROPHOTOMETRY, SPECTROPOLARIMETRY, AND DTA. Deschreider, A. R. (Ministere des Affaires Economiques, Brussels (Belgium)). 8 Oct 1969. 22p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 4,20.

Gamma rays induce physical and chemical changes in wheat flour, the nature and intensity of which depend on the radiation dosage. Results are reported from an investigation of how these changes can be detected and measured by means of spectrophotometric, spectropolarimetric, and differential thermal analysis (DTA) methods. The techniques used are described and the action of the gamma irradiation on the constituents of flour are discussed. By means of DTA changes can be detected only from a dosage of 4 Mrad upwards, by means of spectrophotometry from 1 Mrad upwards. Spectropolarimetric and turbidimetric methods on the other hand are sensitive to doses of 0.025 Mrad. (auth)

23411 (ORNL-tr-2307) EFFECT OF FOODS PASTEURIZED BY GAMMA RADIATION ON WHITE RATS. Shillinger, Yu. I.; Kachkova, V. G.; Kamal'dinova, Z. M. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Vop. Pitan.; 26: No. 3, 72-8(1967). 11p. Dep. CFSTI.

In chronic experiments on 5 generations of albino rats, the effects produced by a ration containing a number of products (meat, oats, grits and potatoes) treated with different doses of γ radiation were studied. A long-term feeding (8 to 10 months) on irradiated products did not exert any visible influence. An unfavorable effect on reproduction was noted, expressed in lengthening of the term of the first delivery and a tendency toward reduced survival of the progeny in the first month of life. A certain increase in the incidence of intercurrent diseases (pneumonia) was recorded in experimental rats, as compared to control animals. (auth)

23412 (TID-25288(Vol.2)) CHRONIC ANIMAL FEEDING STUDIES ON RADIATION-PASTEURIZED CLAMS. CHICKEN FEEDING EXPERIMENTS. Final Report. Fegley, Harry C.; Edmonds, Russell S. (Affiliated Medical Enterprises, Princeton, N. J.). 7 May 1969. Contract AT(30-1)-3573. 164p. Dep. CFSTI.

Laboratory data were analyzed for second generation chickens following feeding of irradiated clams. Data were collected and tabulated for body weight, femur length, hatchability, viability, survival, hematology, clinical chemistry, pathology, and organ weight. It was found that there was a significant increase in body weight of males, the fertility rate was increased, hatchability was increased, and hemoglobin values were increased. (H.L.W.)

23413 SANE PERSPECTIVES REGARDING RADIATION EFFECTS. Goldblith, Samuel A. (Massachusetts Inst. of Tech., Cambridge). Food Technol.; 24: No. 3, 44-6; 48; 50(Mar 1970).

The Food Additives Amendment of 1958 is discussed as a frame of reference for the symposium on radiation preservation of foods. Potential problems concerning effects of ionizing radiation on foods are nutritional quality, production of toxic agents, carcinogenicity, production of induced radioactivity, and microbial interaction. It is emphasized that exposure of foods to ionizing radiation results in destruction of nutrients depending on the dose applied and the relative radiosensitivity of the particular nutrient. A review of the literature on production of toxic substances in irradiated foods indicates that no demonstrable toxicity has been shown in irradiated foodstuffs. Animal feeding tests indicate that no demonstrable carcinogenicity has been shown. A review of studies on induced radioactivity led to the conclusion that the induced activity level in most foods is less than one-twentieth of the natural activity present before irradiation. (H.L.W.)

23414 STUDIES ON TEXTURAL STABILITY OF IRRADIATED BOMBAY DUCK. Gore, M. S.; Kumta, U. S. (Bhabha Atomic Research Centre, Trombay, India). Food Technol.; 24: 80-3 (Mar 1970).

Optimum conditions of dip time and concentrations of salt solutions for minimizing drip losses of unirradiated and irradiated (0.5 Mrad) Bombay duck (Harpodon nehereus) fillets have been established. Irradiated fillets without dip treatment exude about 20% drip. Pre-dip treatment in 10% Na-tripolyphosphate for 15 min and 10% NaCl for 60 min reduces the drip losses to 7–8% during a storage period of 21 days at 10 to 12°C. Pre-irradiation treatment confers textural stability and irradiation augments the storage life of Bombay duck, otherwise susceptible to textural damage and bacterial spoilage. (auth)

23415 INHERITED STERILITY IN PROGENY OF IRRADIATED MALE TOBACCO BUDWORMS: EFFECTS ON REPRODUCTION, DEVELOPMENTAL TIME, AND SEX RATIO. Proshold, F. I.; Bartell, J. A. (Agricultural Research Service, Fargo, N. D.). J. Econ. Entomol.; 63: 280-5(Feb 1970).

When male Heliothis virescens (F.) were irradiated with 15 or 22.5 kR of gamma irradiation, the F_1 progeny were nearly sterile,

and the F_1 male progeny did not mate or transfer sperm as well as normal males. When the dose to the P_1 male was 15 kR, about $\frac{1}{3}$ of its male progeny did not mate, and only about $\frac{1}{2}$ those that mated transferred sperm; with increased dose, this inability to mate increased. The percentage of the F_1 female progeny that mated was nearly as high as the percentage of normal females, but fecundity was markedly reduced when the P_1 male was irradiated with 15.0 or 22.5 kR. Also, the F_1 progeny had a delayed developmental time, increased larval and pupal mortality, and a distorted sex ratio (about 2 males/female). The application of inherited sterility has several advantages in controlling field populations. The main benefit results from the use of P_1 males with less irradiation-induced damage. The data indicate that the dose of radiation given to the P_1 males might be lowered to 15 krad. Such males would be more competitive with native males; thus, by overflooding a field population, one would reduce the population density and alter the population structure to one made up largely of sterile individuals. Then continued releases of such males might achieve eradication. (auth)

23416 ROLE FOR STERILE FEMALES IN INSECT CONTROL. Whitten, M. J.; Taylor, W. C. (CSIRO, Canberra, Australia). J. Econ. Entomol.; 63: 269-72(Feb 1970).

The principle of separate release of γ radiosterilized males and females into different areas, as a means of enhancing the efficiency of the sterile-male technique of insect control, was studied using small laboratory cages. Use was made of a genetic system to separate males from females in the pupal stage of Lucilia cuprina (Wiedemann) rapidly and accurately by machine. It was found that swamping a population with sterile females leads to ineffective or noninsemination of normal females because of the limited mating capacity of males (an average of 10 matings per male). Thus in nature the separate release of sterile females could lead to a decline in population size. (auth)

23417 ERADICATION OF THE ORIENTAL FRUIT FLY FROM THE MARIANA ISLANDS BY THE METHODS OF MALE ANNIHILATION AND STERILE INSECT RELEASE. Steiner, L. F.; Hart, W. G.; Harris, E. J.; Cunningham, R. T.; Ohinata, K.; Kamakahi, D. C. (Agricultural Research Service, Honolulu, Hawaii). J. Econ. Entomol.; 63: 131-5(Feb 1970).

Sterile oriental fruit flies, Dacus dorsalis Hendel, emerging on Guam from 36 million γ irradiated pupae, placed at the loci of infestations established with traps baited with methyl eugenol, eradicated the abnormally small population present after host crops were destroyed by typhoons Karen in 1962 and Olive in 1963. The several reintroductions that occurred in 1964 and 1965 before effective quarantines were established were eradicated by the same method before September 1965. Similar releases on Saipan and Tinian were not successful. Too many flies died before reaching sexual maturity, perhaps because sufficient natural food was lacking near the emergence sites (honeydew-producing insects were suppressed by the typhoons) and because of damage by overheating during movement from Guam to field cages on Saipan. Eradication was finally achieved on these islands in 1965 by distributing fiberboard squares impregnated with methyl eugenol and noted every two week period for $4\frac{1}{2}$ months (method of male annihilation). The Mariana Islands, which have been infested with the oriental fruit fly for at least 35 years, have now been free of the species for more than four years. (auth)

23418 COMMERCIAL FEASIBILITY OF IRRADIATING HADDOCK AND COD FILLETS: INTRODUCTION. Kaylor, John D.; Murphy, Edward J. (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.). Fish. Ind. Res.; 6: 1-3(Mar 1970).

The feasibility of radiation processing of cod and haddock fillets landed in New England on a commercial scale was investigated. It was concluded that low-dose γ irradiation of fresh fillets significantly extends the shelf life of the fish when shipped under commercial conditions at iced temperatures. The organoleptic qualities of the irradiated fillets were similar to the non-irradiated product. (C.H.)

23419 COMPARATIVE EFFECTS OF CHEMOSTERILANTS ON SPERMATOGENIC STAGES IN THE HOUSE FLY. II. RECOVERY OF FERTILITY AND SPERM TRANSFER IN SUCCESSIVE MATINGS AFTER STERILIZATION WITH 1,3-PROPANEDIOL DIMETHANESULFONATE OR X-RAYS. LaChance, Leo E.; Degrugillier, Maurice; Leverich, Ann P. (Agriculture Research Service, Fargo, N. Dak.). Ann. Entomol. Soc. Amer.; 63: 422-8(Mar 1970).

When two- to three-day-old male Musca domestica L. (Diptera: Muscidae) were injected with 20 μg of 1,3 propanediol dimethanesulfonate, most sperm had dominant lethal mutations so the males were sterile in the initial matings. Testes sectioned at regular intervals postinjection contained damaged meiotic and premeiotic cells; pycnotic nuclei were observed one day postinjection; and spermatocytes with chromosomal bridges and fragments were observed the 2nd and 3rd day postinjection. Also, the testes contained few spermatocytes the 4th and 5th day postinjection, thus spermatids were scarce the 5th and 7th day. However, sperm production was never completely interrupted, and the level of spermatogenesis 11 to 13 days postinjection was returning to normal levels. In contrast, when males were treated with 3 kR of x rays, all sperm contained dominant lethal mutations, all gonial cells were killed, and the spermatogenic cycle ceased. Males that mated repeatedly after treatment with the chemosterilant recovered their fertility and became as fertile as the controls after seven to eight matings, but the males that did not remate repeatedly did not recover fertility. There was little difference between fertility of males mated one, seven, or 12 days posttreatment if they remained celibate in the interim. Irradiated males were able to transfer sperm for many matings over several weeks. (auth)

23420 CHANGES OCCURRING IN MILK POWDER SUBJECTED TO GAMMA RAYS. Luczak, M. Zesz. Probl. Postepow Nauk Roln.; 80: 497-501(1968).

Organoleptic alterations were evaluated in whole milk and milk powders under the influence of various doses of γ rays, and the changes occurring in the total number of bacteria as well as the quantitative changes in vitamins B_1, B_2, B_{12} and biotin contents were studied. The experiments proved that: The threshold dose for whole milk powders in the conditions of the experiment was 4.5×10^4 rads. A decrease of the total number of bacteria was noted in irradiated whole milk powder. Losses in vitamin B_1, B_2, B_{12} were noted in irradiated whole milk powders. Biotin proved to be radiation-resistant, regardless of irradiation dose. (auth)

23421 EFFECTS OF GAMMA RADIATION ON THE ABILITY OF THE ADULT FEMALE GYPSY MOTH TO ATTRACT MALES. Statler, M. W. (Agricultural Research Service, Otis AFB, Mass.). J. Econ. Entomol.; 63: 163-4(Feb 1970).

No significant difference was found in the ability of γ radiosterilized female and normal female Porthetria dispar (L.) to attract male moths in a natural infestation. As a supplementary part of the test, two lures were compared also with the attractiveness of sterile and normal females in two of the three trials. There was no significant difference between the abilities of the sterile and normal females to attract males. The 1962 gyplure was as effective as the females in attracting males, but the 1967 Spanish natural lure was less effective. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 22665, 22878, 23502, 23504, 24148, and 24784.

23422 (BNL-50223) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 7, Number 6. (Brookhaven National Lab., Upton, N. Y.). Dec 1969. 47p. Dep. CFSTI.

Reviews of information related to liquid metal technology are included on fluid dynamics, heat transfer, corrosion and erosion, instrumentation, component development, systems studies, chemistry, fabrication, safety and liquid metal purification. (J.R.D.)

23423 (COO-1778-5) METALLURGICAL APPLICATION OF AUGER ELECTRON SPECTROSCOPY. Stein, D. F. (Minnesota Univ., Minneapolis); Weber, R. E. (Physical Electronics Industries, Edina, Minn.); Palmberg, P. W. (North American Rockwell Corp., Thousand Oaks, Calif.). [1970]. 24p. Dep. CFSTI.

Information on the physics, history, experimental procedures and uses of this technique is presented. It is noted that auger electron emission spectroscopy shows promise in many areas of metallurgical research. The advantage of the technique is its application to sampling of very thin layers and its sensitivity to all of the elements, including the light elements. The technique is developed at the present time such that it gives reproducible and accurate measurements. (J.R.D.)

23424 (IS-RIC-3) REVIEWS ON RARE EARTHS. A COMPILATION OF BOOKS, CHAPTERS OF BOOKS, JOURNAL ARTICLES, REPORTS, CONFERENCE PROCEEDINGS AND BIBLIOGRAPHIES PUBLISHED FROM 1946 TO 1968. Bertrand, C. C.; Gschneidner, K. A. Jr. (comps.) (Ames Lab., Iowa). Jun 1969. 87p. Dep. CFSTI.

The bibliography is composed of about 500 general and specific reviews of papers on rare earths written from 1946 to 1968. However, there are a few books included that were written as early as 1912. (G.M.C.)

23425 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THIN FILMS, 28 APRIL-2 MAY 1969, BOSTON, MASSACHUSETTS. Propst, Franklin M. J. Vac. Sci. Technol., 6: 437-794(July-Aug. 1969). (CONF-690435).

A total of 107 papers and abstracts were presented at the conference on the formation and properties of thin films. A separate abstract was prepared for each of 5 papers. The remaining papers include information on structure, optical properties, electric properties, defects, and recrystallization. The materials investigated include metals, semiconductors, insulators, superconductors, oxides, etc. (D.L.C.)

For abstracts of individual papers see: 23469, 23490, 23515, 23530, and 23912.

Corrosion and Erosion

Refer also to abstract 23501.

23426 (AEC-tr-6984) CORROSION OF STRUCTURAL MATERIALS IN SODIUM. Nevzorov, B. A. Translation of Korroziya Konstruktsionnykh Materialov v Natrii, Atomizdat, Moscow, 1968. 106p. (TT-69-55017; IPST-Cat.-5447). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 53315.

23427 (ANL-Trans-798) SEMI-ANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY, JUNE-NOVEMBER 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Sections 4, 5, and 6, pp 126-30; 154-5; 168-80 of report CEA-N-1148. 22p. Dep. CFSTI.

Abstracts of this paper, prepared from the original language, appeared as NSA 24: 11502, 24: 11652, and 24: 12352.

23428 (BNWL-1261) MARK I PROTOTYPIC FTR FUEL ELEMENT SUBASSEMBLY SODIUM FLOW TEST. Millhollen, M. K.; Bennett, T. J.; Myers, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 77p. Dep. CFSTI.

A Mark I prototypic FTR fuel element subassembly was tested in flowing 1060°F sodium in the Core Components Test Loop (CCTL) at Argonne National Laboratory. The subassembly comprised 217, 0.250-in. diameter by 71-in. long fuel pins, assembled into a hexagonal array on a bottom grid arrangement and contained within a hexagonal flow duct. The flow duct shape changed from hexagonal to round above the fuel section of the pins. Individual pins were wire wrapped on a 12-in. pitch with 0.030-in. diameter wire, which provided constant pin spacing in the bundle. Cladding, wire wrap and flow duct were fabricated from Type 304 SS. The subassembly was under flow test in the CCTL for 5067 hr, 3687 of which were at full sodium flow (400 gal/min) and isothermal temperature (1060°F) conditions. Sodium chemistry was checked frequently to ensure that the oxygen content of the coolant did not exceed 10 ppM and that the carbon content did not exceed 20 ppM. When the subassembly was finally removed from the test loop, it was immersed in Dowanol-EB and then in alcohol to remove residual sodium. No significant surface corrosion was observed on the wire wrap, cladding or flow duct. Dimensions of the fuel pins did not change appreciably, but all wire wraps loosened, some as much as 0.006 inch. There was no evidence of vibration-induced damage to neighboring cladding by the loose wire wrap, but there was slight flattening (up to 0.002 in.) of wires in the rows adjacent to the flow duct. (auth)

23429 (COO-2018-4) STRESS CORROSION CRACKING AND GENERAL CORROSION OF IRON, NICKEL, CHROMIUM, AND THEIR ALLOYS IN CAUSTIC SOLUTIONS. Quarterly Report, January 15, 1969-April 15, 1969. Subrahmanyam, D. V.; Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). 2 Feb 1970. Contract AT(11-1)-2018. 124p. Dep. CFSTI.

This review considers the problems of general corrosion and stress corrosion cracking for Fe-Cr-Ni alloys in caustic environments. Environments considered are primarily NaOH-H_2O over a broad range of temperatures. Information is presented in areas of thermodynamics, electrochemical kinetics, corrosion rates, SCC phenomena, structures of passive films, and inhibitors. Materials considered are iron, chromium, and nickel, as well as binary and ternary alloys. (auth)

23430 (ORNL-TM-2836) PENETRATION OF REFRACTORY METALS BY ALKALI METALS. Klueh, R. L. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Under certain conditions liquid alkali metals penetrate tantalum and niobium rapidly along grain boundaries and certain crystallographic planes. Penetration is observed only when oxygen dissolved in the refractory metal exceeds some threshold concentration, which depends upon the refractory metal, the alkali metal, and the temperature. Penetration was first encountered in niobium and tantalum exposed to lithium, but has now been found when these metals are exposed to sodium, potassium, and the sodium-potassium eutectic. Oxygen levels required to effect penetration in niobium and tantalum by lithium, sodium, and potassium at 600°C are compared, and the rate of penetration is discussed in terms of a corrosion model. (auth)

23431 CORROSION OF FUEL CAPSULES BY AND RELEASE OF RADIONUCLIDE FUELS TO SEAWATER. Mikhail, S. Z.; Kubose, D. A. (Naval Radiological Defense Lab., San Francisco). Nucl. Met., Met. Soc. AIME; 14: 323-54(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The release of radionuclides from radioisotope heat sources to the ocean environment was studied. Both laboratory and in situ ocean tests were carried out on the fuels as well as on encapsulant materials. Seawater corrosion and corrosion-erosion rates of the encapsulants were measured in the laboratory using electrochemical and radioactive tracer techniques. Corrosion data obtained to date are summarized. In situ ocean testing utilized electrically heated and radioisotopic fuel-loaded capsules. Fuel dissolution rates were measured in the laboratory under different conditions. Plutonium dioxide fuel was exposed in the ocean for 5 months. Results of the post-exposure examinations are reported. The ocean tests were conducted at San Clemente Island. (auth)

23432 FILAMENT REINFORCED METALLIC COMPOSITES. Greene, N. D. Jr. (Univ. of Connecticut, Storrs); Ahmed, N. Mater. Protect.; 9: 16-18(Mar 1970).

The corrosion of filament reinforced composites is controlled by the specificity of the environment and galvanic interactions between components. Examples of these aspects are discussed. (auth)

23433 OXIDATION OF VANADIUM NITRIDE IN FLOWING OXYGEN. Borgianni, C.; Di Stefano, V.; Grimaldi, R. (Centro Sperimentale Metallurgico S.p.A., Rome). J. Less-Common Metals; 20: 299-307(Apr. 1970).

The oxidation of vanadium nitride was studied by means of thermogravimetric and differential thermal analysis (DTA) with linearly increasing temperature. Five DTA peaks were detected. The substances obtained at the termination of each peak were submitted to chemical and x-ray analyses. Characteristic, apparent values for the activation energy and for the reaction order were assigned to each of the first three peaks. Possible explanations of the observed reactions are advanced. (auth)

23434 DECONTAMINATION AND CORROSION OF ALUMINUM BY SELECTED DECONTAMINATION SOLUTIONS. Zaric, Lj.; Jelic, L.; Matijasic, A. (Boris Kidric Inst. of Nuclear Science, Belgrade). Isotopenpraxis; 6: 26-9(Jan 1970).

Decontamination and corrosion have been studied in the following solutions: chromic-phosphoric acid, diammonium citrate, triammonium citrate and the tetrasodium salt of EDTA. High decontamination factors of aluminum, contaminated with ^{60}Co, were obtained in the solutions of chromic-phosphoric acids, di- and triammonium citrate. In the solution of the tetrasodium salt of EDTA, decontamination factors were low. Highest uniform corrosion has caused a solution of the tetrasodium salt of EDTA, up to 11 $g/m^2/hr$. The solution of triammonium citrate had very mild uniform etching action on aluminum. Total weight losses observed in the diammonium citrate solution were approximately equal, while corrosion was nonuniform. This solution caused a local attack and pits. Chromic-phosphoric acid had also slight action on aluminum. (auth)

23435 CORROSION RESEARCH OF FISSIONABLE MATERIALS. van der Linde, A.; van Tilborg, P. J. Atoomenergie Haar Toepass.; 12: 35-45(1970). (In Dutch).

The metal cladding which protects the fissionable material against attack by the reactor coolant must be sufficiently strong throughout the lifetime of the fuel element; it must resist corrosion both from the inside and the outside and must have a low thermal and fast-neutron cross section. Zircaloy was found to be suitable for water-cooled reactors and nickel alloys for the helium-cooled systems. Corrosion research on these alloys at the Reactor Center Netherlands is reviewed. Roentgenographic technique was used to determine the metal content of the oxide layers, to predict the contamination of the coolant with radioactive corrosion products and to correlate corrosion with changes in the composition of the oxide. Corrosion of Zircaloy in boiling water was determined for operations up to 900 days. The results of corrosion testing of three nickel-base alloys—Inconel-625, Hastelloy X-280 and Incoloy-800—are presented in tabular and graphic form. Electropolishing and etching increased the oxidation of Incoloy-800 but affected only slightly the other two alloys. (TTT)

Preparation and Fabrication

Refer also to abstracts 22735, 22852, 23935, 24854, and 24891.

23436 (IS-2184) AN ANNOTATED BIBLIOGRAPHY FOR GROWTH OF MULTI-ELEMENT SINGLE CRYSTALS OF METALS AND METALLOIDS. Murtha, M. J.; Burnet, George (Ames Lab., Iowa). Feb 1970. Contract W-7405-eng-82. 29p. Dep. CFSTI.

A list of abstracted references specifically relating to the growth of binary and multi-element metal and metalloid single crystals is presented. These references provide information required for preparing many compound single crystals, and is a guide for the preparation of new compound single crystals. Indexes by compound and growth method are included. (auth)

23437 (UCRL-50766) HIGH-STRENGTH, LOW-TEMPERATURE BONDING OF BERYLLIUM AND OTHER METALS. Knowles, James L. (California Univ., Livermore. Lawrence Radiation Lab.). Feb 1970. 119p. Dep. CFSTI.

The feasibility of techniques for bonding beryllium as well as other metals at low temperatures was investigated and the relationship of the bond parameters to the bond strength was determined. This study was guided by the following conditions: bonding temperature should be less than 600°F; plastic deformation of the parent metal should be minimized; and the bond should be nearly as strong as the parent metal. The final condition was intended to apply to type S 200 C beryllium. Most of this study concerned beryllium, but additional tests were made on molybdenum, stainless steel, tungsten, and commercially pure copper. Bonds could not be accomplished within the required temperature range and with small parent metal distortion without the use of an intermediate material. Consequently, all the results reported herein are for specimens with a plated dissimilar metal, generally silver, on the surfaces being joined. A special cleaning treatment was required after this second material was applied. Bonding atmospheres varying from a vacuum of 2×10^{-4} torr to helium, oxygen, and air had no significant influence on bond strength. Variations in the bonding procedure, with a consequent resulting difference in strengths obtained, led to the conclusion that the elastic strain energy in the substrate acted to destroy some portion of the bond by fracturing a portion of the bond area. For a fixed applied bonding compressive stress, bond strength increased when the modulus of elasticity of the substrate was increased. The thickness of the intermediate material was also significant in determining bond strength for the same processing conditions. When the plating thickness was varied from 35 μin. to 200 μin., the bond strength was approximately doubled. The presence of the plated material and the subsequent preparation of the surface resulted in a very small notch in the surface of the specimen at the bond interface. When this imperfection was removed after bonding, the bond strength was again almost doubled. Data from beryllium tests showed that a partial bond was formed at a temperature of slightly less than 225°F. At 280°F, bond strengths in beryllium could be obtained approaching that of the bulk material with a plating thickness of approximately 200 μin. Also, bond strength increased linearly with increased applied bonding compressive stress. This result fits the adhesion model of bonding. It may be concluded that bonds that exhibit beryllium fracture strength (40 ksi) and that have been especially prepared after plating can be made at 225°F on plated beryllium. The experimental data indicate that an adhesion or cohesion model is the bonding mechanism. This conclusion is based on the linear relationship of the bond strength to bonding compressive stress and the independence of bonding time. Bond strengths are very dependent upon the thickness of the plating; the strengths increase with increasing thickness up to 600 μin. (auth)

23438 (WARD-4135-5) STAINLESS STEEL CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1969. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb 1970. Contract AT(30-1)-4135. 79p. Dep. CFSTI.

Microcharacterization and mechanical property testing including biaxial tensile, stress rupture, and both uniaxial and biaxial creep were conducted on vacuum melted steels. Specimens of double vacuum melted 20% cold worked tubing were heat treated according to several schedules including one reported to give enhanced mechanical properties. These specimens have been tested and compared with the as-fabricated material. A limited series of biaxial tensile tests were conducted in which hold time prior to test was varied to determine the effect this variable had on the test data. Comprehensive structural characterization of two double vacuum melted tubing lots has been completed. Additional low cycle high strain fatigue tests were delayed pending proof testing of a new specimen design. An investigation of the effects of degree of cold work on weldability has also been completed. A shipment of 200 feet of 20% cold worked double vacuum melted Type 316 tubing, manufactured by planetary swaging, has been received for use in the characterization studies. Mechanical property testing was initiated. A shipment of 250 feet of 20% cold worked double vacuum melted Type 316 tubing has been received for use in the Oxide Fuel Element Development Program. (auth)

23439 (Y-SC-3) MACHINING TYPE AM 363 STAINLESS STEEL. Hensley, J. D.; Shell, M. L. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 7 Apr 1970. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Machining tests were conducted on Type AM 363 stainless steel to determine the optimum machining conditions under single-point turning. For finish cuts, the work was performed on an American duplicator lathe. The workpiece was a log approximately 15 inches long and 5 inches in diameter. Results of the tests are presented and are the basis of recommended machining parameters. (auth)

23440 REMOTE ENCAPSULATION TECHNIQUES FOR STRONTIUM AND CURIUM FUEL FORMS. Donnelly, R. G.; Gunkel, R. W. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME; 14: 211-22(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The encapsulation of strontium and curium compounds for isotopic power sources required welding by remote means in a hot cell. In the past, strontium-fueled superalloy containers were welded by the gas tungsten-arc process. More recently, electron-beam welding was also used. This process gave increased penetration, melted less material, provided a more inspectable weld, and was ideally suited to remote operation because the beam could be controlled electromagnetically. Refractory alloys were the most likely materials for containing curium because of the stress buildup from helium generated by alpha decay and because of the very high temperatures for possible applications. Since helium

buildup required the container to be a pressure vessel, full-penetration welds were necessary. This presented no particular problem when the electron-beam process was used because a vacuum atmosphere was maintained, but with the gas tungsten-arc process, a vent was required to relieve pressure that was built up by welding heat. Examples of each of the various types of welds and in-cell welding equipment are presented. (auth)

23441 PROCESS FOR POSITIONING A WIRE ALONG A HELICAL PATH ON A CYLINDRICAL FUEL ELEMENT. Brard, Jean-Claude (to Commissariat a l'Energie Atomique). British Patent 1,186,321. 2 Apr 1970. Priority date 28 Jul 1967, France.

A process for positioning a wire along a helical path on a cylindrical fuel element is described. The fuel can is rotatable around its lengthwise axis and provisions are made for guiding the wire for positioning in its helical path. (J.R.D.)

23442 REACTOR WELDING WITH BEAD AXIS PERPENDICULAR TO JOINT AXIS. Bunn, W. B.; Berger, C. F. (Combustion Engineering, Inc., Chattanooga). Weld. J. (N. Y.); 49: 194; 197-203(Mar 1970).

New submerged-arc and manual covered-electrode welding procedures are being used for nuclear light-water reactor fabrication. The axes of the shell course longitudinal joints were positioned vertically, and weld beads were deposited through the thickness of the joints. The weld joint quality was determined to be excellent. These procedures have become established as standard practice in a plant expansion for reasons which are detailed. (auth)

23443 RHENIUM-REFRACTORY METAL ALLOYS. Peters, John E. (to The Chase Brass and Copper Co., Inc.). U. S. Patent 3,503,720. 31 Mar 1970. Filed 26 Jul 1967.

Pre-alloyed metal powders of rhenium-tungsten and rhenium-molybdenum are disclosed, together with sintered slugs of such pre-alloyed metal powders, having unique properties for the preparation of refractory metal alloys useful in the fabrication of various components by powder metallurgy techniques. (Offic. Gaz.)

23444 STUDY OF FORGEABLE CHROMIUM-BASE ALLOY. Yoshida, Heitaro; Koike, Kisaburo; Yoda, Renpei (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 34: 52-8 (Jan 1970). (In Japanese).

In order to obtain forgeable chromium-base alloy having excellent creep rupture strength, various kinds of 60% chromium-base alloys, containing more than 10% molybdenum, boron, titanium, zirconium, and carbon, and the alloys in which a part of iron was replaced with cobalt were melted in vacuum. The possibility of hot forging and the effect of these elements on the high-temperature properties were then investigated. The results obtained are as follows. When ingots were heated, protection from the heating atmosphere was needed, and the preferable heating temperature range was 1200 to 1300°C. Hot working was possible up to 20% molybdenum by dynapak forging and up to 15% molybdenum by press forging. The conditions in which hot working was possible mainly depended on the alloy composition, with no relation to the purity of raw materials. Addition of a small amount of titanium was effective for improvement of ductility at high temperature. But, the addition of a large amount of titanium caused the alloy to precipitate the σ phase easily, thus deteriorating the ductility of the alloy at high temperature. Additions of carbon, boron, zirconium, and titanium had little effect on the improvement of creep rupture time. Selection of an optimum alloy composition was essential to increase the molybdenum content and also to utilize the precipitation of the σ phase in the range in which hot working was possible. In this study, the composition in which hot working was possible and had a most excellent creep rupture strength was 58% Cr-12.5% Mo-5% Co-2% Ti-bal. Fe. (auth)

23445 FABRICATION OF Nb-Zr SUPERCONDUCTING WIRES. Nobuki, Minoru; Tachikawa, Kyoji (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 34: 88-94(Jan 1970). (In Japanese).

Nb-Zr alloys containing 25, 50, and 70 at.% Zr were fabricated into long fine wires. The most suitable lubrication for the drawing was coating the wires with a layer of graphite or MoS_2. The layer was formed by applying colloidal solutions of these lubricants and subsequent drying up at 120 to 150°C in hot blasts. The friction coefficients between the wires and the WC drawing dies were measured by the separate die method. The friction coefficients during the continuous drawing were 0.07 to 0.08 for graphite coating and 0.05 for the additional coating of MoS_2. These values were a few tens of percent larger than those measured by the reciprocal friction testing machine. The die angle which minimized the drawing force was between 18 and 20°. The calculated drawing forces were in good agreement with the observed values. The influences of the intermediate annealing temperatures and the reduction of drawing upon mechanical and superconducting properties of the wires were also investigated. The wire annealed between 700 and 850°C and then drawn about 96% showed the highest superconducting current capacity. (auth)

23446 SOLDERING OF CARBONITRIDES WITH REFRACTORY METALS. Archakova, G. G.; Burykina, A. L.; Evtushenko, O. V.; Prshedromirskaya, E. M. (Inst. of Problems in Material Studies, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 52-5(Jan 1970). (In Russian).

A method of boron carbonitride soldering with refractory metals (niobium, molybdenum and tungsten) was developed using molybdenum disilicide as a refractory solder. As a result of the tests it is shown that the developed technology ensures the conservation of the electric resistance of soldered elements within the limits 10^{13} ohm/cm and gas density of the soldered joint during the pressure drop from 5 to 1 gage atmospheres. (auth)

23447 NEW TRENDS IN THE IMPULSE PRESSING OF POWDERS. Boginskii, L. (Technische Hochschule, Vienna. Polytechnical Inst., Minsk). Planseeber. Pulvermet.; 17: 225-36(Dec 1969). (In German).

The recently developed new methods of impulse pressing of powders are described and their advantages and disadvantages are discussed. Since high-density compacts of oxides (Al_2O_3, UO_2), carbides (WC), metals (Fe, W, Mo, Al, Cu), and cermet powders ($Al-Al_2O_3$, Al_2O_3-Mo) can be made in this way, the technological feasibility of the process is proved. (auth)

23448 ACTIVATION OF THE PROCESS OF TUNGSTEN SINTERING BY THE METALS OF PLATINUM GROUP. Samsonov, G. V.; Yakovlev, V. I. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 37-44(Jan 1970). (In Russian).

The effect of platinum group metal (Ru, Rh, Pd, Os) additives on the sintering of tungsten within the range of 1000 to 1200° was studied. It is shown that activating effect of the additive is increased in the direction Os → Ru → Rh → Pd. An electronic mechanism was considered for the activated sintering using a model of localization configuration of valence electrons. An activating effect of platinoid additives was shown to be reduced to localization of non-localized electrons of tungsten atoms near the frames of platinoid atoms with general decrease of energy reserve of the whole system in total. Primary electronic transitions from tungsten atoms to platinoid ones condition the high solubility of tungsten in platinoids and its primary (up to unipolar) diffusion into tungsten. (auth)

23449 THE PREPARATION OF AN ALUMINIUM-NIOBIUM ALLOY. Beghi, Giorgio; Piatti, Giovanni (to European Atomic Energy Community). British Patent 1,188,590. 22 Apr 1970. Priority date 25 Jul 1966, Italy.

A process for production of a binary Al-Nb alloy containing $NbAl_3$ particles dispersed in Al matrix is described. The alloy has up to 20% by weight of Nb. The mixture is heated to 1800°C and cast under conditions of high cooling rate. (J.R.D.)

23450 A URANIUM ALLOY WITH A LOW MOLYBDENUM CONTENT. Lerouge, Georges (to Commissariat a l'Energie Atomique). British Patent 1,188,740. 22 Apr 1970. Priority date 11 Aug 1967, France.

A method of preparing low Mo content μ alloys for reactor fuel elements is described. The basic alloy contains 0.03 to 0.25 wt % Mo, 0.02 to 0.15 wt % Sn and the remainder μ and impurities. One modified alloy also contains 0.02 to 0.15 wt % Si. Another modification contains additional 0.02 to 0.2 wt % Al and 0.02 to 0.08 wt % Cr. A third modification contains an additional 0.02 to 0.08 wt % iron. (J.R.D.)

Properties Evaluations

Refer also to abstracts 22870, 22881, 23432, 23438, 23518, 24495, 24834, and 24835.

23451 (AD-698357) THE THERMAL CONDUCTIVITY AND TOTAL EMITTANCE OF TUNGSTEN AT 1800 TO 2800 K. Technical Report, September 1, 1967-June 30, 1968. Jun, C. K.; Ebrahim, Salman; Hoch, M. (Cincinnati Univ., Ohio). Oct 1969. Contract F33615-67-C-1445. 52p. (AFML-TR-69-275). CFSTI.

The thermal conductivities and total emittances of six tungsten samples prepared by different manufacturers using either arc-cast methods or powder metallurgy techniques were measured in the temperature range 2000 to 2800°K. The thermal conductivity of commercially prepared arc-cast samples was slightly higher than the thermal conductivity of commercially prepared powder

metallurgy samples. In both cases the thermal conductivity was independent of temperature. The total emittance at 2500°K for the powder metallurgy samples was 0.25 and 0.29 for the arc-cast samples. The specially prepared materials had thermal conductivities and emittances which were different from the conductivity and emittance of commercially available materials. (auth) (USGRDR)

23452 (AEC-tr-6980) YTTRIUM: PROPERTIES, PHASE DIAGRAMS, AND INDUSTRIAL APPLICATIONS. Terekhova, V. F.; Savitskii, E. M. Translation of Ittrii, Izdatel'stvo, Nauka, Moscow, 1967. 167p. (TT-69-55016; IPST-Cat.-5414). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 38511.

23453 (CEA-N-1178) IMPROVEMENTS TO THE APPARATUS FOR DISSOLUTION OF NaK AT LECI. Mansard, Bernard; Ducas, Serge; Riviere, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec 1969. 13p. (In French). Dep. CFSTI (U. S. Sales Only).

A method for the dissolution of NaK in ethanol is described. A new device makes the treatment of 400 to 600 cm^3 NaK possible. Its design is outlined. (France)

23454 (EURAEC-2138) [PROGRESS REPORT, SEPTEMBER 30, 1969–DECEMBER 30, 1969]. (Ghent Rijksuniversiteit (Belgium). Laboratorium voor Weerstand van Materialen). Contract 081-67-1-TEEC(RD). 6p. (EUR-4028). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Four Robertson tests were carried out on Types 5 RD 81, 6 RD 81, 9 RD 81, and 10 RD 81 steel specimens at 63 or 100 mm thickness. The crack arrest temperature for certain conditions of thickness and stress is estimated. (J.C.W.)

23455 (GEAP-13550) INFLUENCE OF SURFACE DEFECTS ON SHORT-TERM MECHANICAL PROPERTIES OF AUSTENITIC STAINLESS STEEL TUBING. Lauritzen, T.; Montes, A.; Conti, A. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Dec 1969. Contract AT(04-3)-189. 32p. Dep. CFSTI.

The short-term mechanical properties of austenitic stainless steel tubing containing local surface defects were evaluated by burst techniques. Thin-wall tubing of Type-316 with both naturally occurring and artificially-impressed defects was tested at 1100 and 1300°F. Nine tubes containing longitudinally-oriented surface defects failed at and along the defect. All but one of six tubes, which contained circumferentially and diagonally oriented defects, failed elsewhere. Longitudinal defects as deep as 25% of the wall and $\frac{1}{8}$-inch long caused reductions in hoop strength no greater than 6% at 1300°F. This reduction is reflected in a 50% drop in fracture ductility. Tubes tested with circumferential and diagonal defects ranging in depth from 9 to 16% of the tube wall showed reductions of not more than 4.6% in hoop strength at 1300°F; these defects showed no perceptible effect on diametral ductility. Tubes with naturally occurring surface defects ranging from 5 to 10% of the tube wall showed 0 to 3% reductions in hoop strength at 1100°F and 0 to 4.6% reductions at 1300°F. Diametral ductility of the tubes tested at 1100°F was not adversely affected by the presence of defects. In the 1300°F tests, on the other hand, the defect size was generally reflected in a reduction in ductility. Tubes with 10% wall defects, for example, showed 30 to 50% reductions in fracture ductility. (auth)

23456 (NLCO-1049) EFFECT OF SMALL ADDITIONS OF IRON, SILICON, AND ALUMINUM ON THE HARDNESS AND DEFORMATION OF CAST URANIUM AT ELEVATED TEMPERATURES: STATISTICAL EVALUATION. Randall, P. L. (National Lead Co. of Ohio, Cincinnati). Mar 1970. Contract AT(30-1)-1156. 12p. Dep. CFSTI.

Mechanical property data from 27 cast alloys of the U–Fe–Si–Al system were statistically evaluated. The alloy levels were 300 and 1000 ppM. Hardness and drop hammer values were obtained at temperatures ranging from 885 to 1200°F. Both resistance to deformation and hardness values decreased as temperatures increased and increased as the silicon level increased. (auth)

23457 (Y-1707) COMPRESSIVE STRAIN-RATE PROPERTIES OF THORIUM. Gallman, R. A.; Oakes, R. E. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 3 Mar 1970. Contract W-7405-eng-26. 14p. Dep. CFSTI.

The strain-rate dependence of the mechanical properties of thorium in compression at room temperature was studied using an Instron testing machine and a split Hopkinson bar. Results revealed that thorium is strain-rate dependent even at low strain rates. (auth)

23458 (Y-1708) TENSILE STRAIN-RATE PROPERTIES OF THORIUM. Oakes, R. E. Jr.; Gallman, R. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 27 Feb 1970. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A study was made of the effects of strain rate on the tensile properties of thorium. Over a range of strain rates from 0.01 to 200 sec^{-1}, the yield point, tensile strength, and breaking strength increased proportionally with rate, while the ductility decreased slightly. (auth)

23459 LIQUID METALS AND VAPOURS UNDER PRESSURE. Ross, R. G. (Univ. of East Anglia, Norwich, Eng.); Greenwood, D. A. Progr. Mater. Sci.; 14: 175-252(1969).

A review is presented covering experimental and theoretical work on the properties of liquid metals under pressure, both at higher than normal densities near the normal melting point, and at lower densities in the region of the critical point. Information about the equation of state is summarized, together with some properties of the equilibrium vapour phase. The measurement and prediction of critical point data and the application of the law of corresponding states are also discussed and electrical measurements and electrical conductivity are reviewed. The extent to which present theories are adequate and the theory of the metal-insulator transition are also considered. 147 references. (auth) (UK)

23460 REQUIREMENTS OF RADIOISOTOPE CAPSULE MATERIALS. Holland, J. R. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Met., Met. Soc. AIME; 14: 184-95(1969). (SC-DC-68-2385).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The requirements of capsule materials for radioisotope heat sources are demanding particularly for space applications where the requirements often exceed current materials capabilities and knowledge. The capsules are generally multilayered structures with each layer having a definite function relative to the operating conditions and probable environments. One may classify the radioisotope capsule material requirements as follows: those resulting from the radioisotope fuel and its form; operating conditions such as temperature and life; anticipated and potential environments, e.g., launch accidents, space vacuum, and reentry; and mutual compatibility and stability considerations, arising from capsule materials selection. These requirements are discussed with regard to current practice, materials knowledge, and future needs. The discussion is biased toward space applications since the materials problems encountered seem more exacting and less facile in those applications. (auth)

23461 PROPERTIES AND FABRICATION OF REFRACTORY ALLOYS FOR ISOTOPE CONTAINMENT. Davies, Robert Lee; Moorhead, Paul E. (Lewis Research Center, Cleveland). Nucl. Met., Met. Soc. AIME; 14: 196-210(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Use of isotopic fuels in a high-temperature heat source required the use of refractory metal alloys for containment and also for structure in order to hold fuel capsules in a given geometry. Programs were conducted to determine properties of refractory alloys of interest to space power systems including isotope heat sources. The pertinent properties investigated for the alloys of interest have included fabricability, elevated temperature stability, and long-time creep strength. Data are presented on the bend ductility of various refractory alloys in the wrought, electron-beam welded, and tungsten inert gas welded conditions. Long-time data are presented on the structural stability of the T-111 (Ta-8W-2Hf) alloy. Also presented are creep strength data for various alloys of interest for application to isotope heat sources. In addition, stronger alloys are of interest because they would allow a reduction in structural material thickness or an increase in safety without a weight penalty. The study of advanced alloys resulted in a fabricable, weldable tantalum alloy having a useful design strength at temperatures up to 2600°F. (auth)

23462 EVAPORATION OF RADIOISOTOPE CAPSULE MATERIALS IN VACUUM. Bourgette, D. T. (Oak Ridge National Lab., Tenn.). Nucl. Met., Met. Soc. AIME; 14: 248-70 (1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

The evaporation behavior of stainless steels, superalloys, and refractory alloys was studied. Haynes-25 and type 316 stainless steel were tested at temperatures of 760 to 1150°C and pressures of 10^{-10} to 10^{-7} torr for times to 3500 hr. The role of composition was determined by comparing the evaporation results and microstructures of these alloys with 700-hr tests conducted at 870

and 980°C on Hastelloy N, Inconel, and types 304 and 446 stainless steel. Evaporation rates increased with increasing chromium and manganese concentration and temperature, but decreased with time at constant temperature. Evaporation resulted in surface enrichment of the low vapor pressure elements and bulk changes in alloy composition. This evaporation mode resulted in subsurface void formation, concentration gradients, and changes in the microstructure of each alloy. The creep-rupture properties of type 316 stainless steel were determined in argon after exposure to vacuums of 10^{-7} to 10^{-8} torr for times to 5000 hr at 870°C. Haynes-25 is being evaporation tested at 800°C and 10^{-8} torr while under creep stresses of 2,500 to 15,000 psi to ascertain the effect of stress on evaporation behavior. Results of evaporation tests on tantalum- and niobium-base alloys in high vacuum at temperatures of 1200 to 1500°C showed that no serious evaporation problems exist below 1300°C. (auth)

23463 HEATING TESTS OF ENCAPSULATED COBALT HEAT SOURCES. Angerman, C. L.; Faraci, J. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). (DP-MS-68-20). Nucl. Met., Met. Soc. AIME; 14: 309-22(1969).

From Nuclear Metallurgical Symposium on Materials for Radioisotope Heat Sources, Gatlinburg, Tenn. See CONF-681002.

Capsules of nickel- and cobalt-based alloys that contained unirradiated or irradiated cobalt metal wafers performed satisfactorily during heating tests at typical heat source conditions, 10,000 hr in air at 850 to 1000°C. Typical capsules were 1 to 3 in. long and 0.94 in. in diameter with 0.05- to 0.10-in.-thick walls. Cobalt wafers, 0.040 in. thick, were cleaned, measured, and stacked in capsules that were sealed by TIG welding. The best capsule materials, Haynes 25, Hastelloy X, Hastelloy C, and Inconel 600, were selected from screening tests that were designed to measure the kinetics of the three most important factors affecting the integrity of the heat source capsule. Interdiffusion at the cobalt-capsule interface formed a solid-solution zone that terminated in a band of Kirkendall voids in the capsule material. Radiotracer measurements of diffusion showed that ^{60}Co penetrated significantly along the grain boundaries of the capsule materials. Intergranular penetration and depletion of alloy constituents underneath the continuous oxide scale contributed significantly to the total depth affected by oxidation. Extrapolation of results from these short-term tests indicates that capsule performance would be satisfactory up to 1000°C for service times out to 50,000 hr. Capsule heating tests are continuing to confirm predicted performance to 5 yr. (auth)

23464 PLASTIC DEFORMATION OF MOLYBDENUM–RHENIUM ALLOY CRYSTALS. Davidson, D. L.; Brotzen, F. R. (Rice Univ., Houston, Tex.). Acta Met.; 18: 463-70(May 1970).

A detailed study of the plastic deformation of molybdenum–rhenium single crystals produced by electron-beam zone refining was carried out at temperatures from 78 to 425°K. Direct shear tests were used to apply the maximum stress to the {110} ⟨111⟩ and {112} ⟨111⟩ systems. Results were generally similar for both orientations. Solute softening was present at low temperatures. Computations of the lattice-frictional stress made on the basis of anisotropic elastic constants revealed a lowering of this stress as a result of rhenium addition, which was in agreement with experimental findings. A dislocation-velocity dependent model was developed to explain the temperature variation of the experimentally observed activation volume. Stacking fault energies were computed for both {110} and {112} faults and found to be of large magnitude, decreasing with rhenium additions. Twinning was observed in the high-rhenium alloy, and a qualitative explanation was offered for its occurrence. (auth)

23465 HOT CRACKING IN FUSION WELDS IN TUNGSTEN. Farrell, K.; Houston, J. T.; Chumley, J. W. (Oak Ridge National Lab., Tenn.). Weld. J. (N. Y.); 49: 132s-7(Mar 1970).

Electron fractography was used to examine porosity and hot intergranular crack formation in the heat-affected zone and weld bead in fusion welds in tungsten. It was demonstrated that cracking was caused by the growth and coalescence of small pores on the grain boundaries. The pores are believed to initiate as gas bubbles, and this affords an explanation of why cracking is confined to the heat-affected zone in some grades of tungsten and to the weld bead in others. Calculations show that it is feasible for suitably arranged pores to grow and coalesce into a grain-boundary crack by a model involving stress-induced diffusion of vacancies into the pores. The possibility of pore growth by mechanical means is also considered. (auth)

23466 ELECTRO-PERMEATION OF HYDROGEN IN METALS. Fullenwider, Malcolm Allan. Philadelphia; Univ. of Pennsylvania (1969). 182p.

Thesis.

A relation of the diffusion coefficient and solubility for hydrogen in metals to the interaction of hydrogen with the metal phase was investigated. Determinations of permeation and diffusion coefficient were made by a very sensitive electrochemical method at room temperature, and in some cases with temperatures up to 80°C, for platinum, nickel, tantalum, titanium, zirconium, manganese, and iron-chromium alloys. The dependence of permeation at high current densities on time varied qualitatively with the metal involved. The diffusion coefficient for iron-chromium alloys decreased with increased chromium; the solubility increased with increasing chromium. In general, the solubility decreased with increasing heat of absorption, and decreased with decreasing d-vacancies. The diffusion coefficient decreased with increasing latent heat of sublimation of the metal. The critical concentration of hydrogen which caused embrittlement in the metal was interpreted in terms of a model involving the pressure of hydrogen in the voids. Qualitative support is cited. Gas phase heats of solution of hydrogen in metals are those obtained for the solution case. Solubility of hydrogen depends upon d-vacancies according to the simple model. A solution of equations relating to the diffusion of hydrogen out of precharged metal foils is given. (Diss. Abstr.)

23467 A STUDY ON SLIDING WEAR MECHANISM OF Cu–Be ALLOY. Takeuchi, Eiichi (Tokyo Metropolitan Industrial Research Inst.). J. Jap. Inst. Metals; 34: 59-64(Jan 1970). (In Japanese).

The wear mechanism for the unlubricated sliding wear for Cu–Be alloy combined with dissimilar metal (carbon steel; S 55C) and also the phenomenon of the metal transfer in the adhesive or thermal wear range were investigated. When BeA-50 (hardness after aging; H_RC 19 to 23) was used as a stator, oxidation caused the main wear at a sliding velocity of 0.05 ~ 0.20 m/sec under a contact pressure of 5 kg/cm², but in BeA-25 alloy (hardness after aging; H_RC 38 to 42), the adhesive phenomenon appeared at a sliding velocity of 0.05 m/sec. When the velocity was between the above value and 0.70 m/sec, however, every alloy suffered a great wear loss owing to the scratching or turning up operation by the adhesive wear marks or the wear debris existing between the sliding surfaces. Besides, the wear resistance in this range was better in BeA-25 alloy with higher hardness. When the velocity was about 4.00 m/sec, thermal wear occurred and conspicuous metal transfer as well as high temperature oxidation was observed; the wear loss was comparatively small. From the wear tendencies observed under the different wear mechanisms, the following fact becomes clear: in the oxidative wear range, the increasing rate of wear loss is small and the wear loss in the adhesive wear range increases almost linearly in proportion to the increasing sliding length, but in the thermal wear range, the high temperature oxidation and the increasing rate of the wear loss are small. The parts generated the metal transfer in the process of wear. Metal transfer occurred all the more easily for similar metals. The transfer-metal generated under high velocity cracked owing to the thermal shock. Diffusion phenomenon between the matrix metals was observed. (auth)

23468 FIZIKO-KHIMIYA SPLAVOV TSIRKONIYA. (Physical Chemistry of Zirconium Alloys). Ivanov, O. S. (ed.). Moscow; Izdatel'stvo Nauka (1968). 276p.

Original data on the structure and properties of zirconium-base alloys are presented including: phase diagrams of ternary systems of zirconium with the most important alloying elements—aluminum, beryllium, chromium, copper, iron, molybdenum, niobium, silicon, tin, vanadium, and others; data on the corrosion of zirconium-base alloys in air, carbon dioxide, and water; and the mechanical properties at 400 to 700°C of binary, ternary, and more complex alloys of zirconium with the above mentioned elements. (tr-auth)

23469 ELLIPSOMETER STUDY OF ANODIC OXIDES FORMED ON SPUTTERED TANTALUM AND TANTALUM–ALUMINUM ALLOY FILMS. Muth, D. G. (Bell Telephone Labs., Inc., Allentown, Pa.). J. Vac. Sci. Technol., 6: 749-52(July-Aug. 1969).

From International Conference on Thin Films, Boston, Mass. See CONF-690435.

During an ellipsometer study of anodized films of tantalum and tantalum–aluminum, the optical properties of both the metal and anodic oxide films were determined. The complex refractive index of normal density (16.0 g/cm³) tantalum films ranges from n = 3.43 – 3.66i (at λ = 5461 Å) for tetragonal (beta) tantalum to n = 2.90 – 2.41i for bcc tantalum. For porous tantalum films, the absorption coefficient decreases from a value of 3.66 for normal density to 1.70 for a density of 11.7 g/cm³. The refractive index of anodic Ta_2O_5 is 2.22 and the dielectric constant is 26.7. For tantalum–aluminum alloy films sputtered from a Ta cathode with 23% aluminum area coverage, n = 3.2 – 2.98i. The anodic oxides of these alloy films act as a mixture of anodic Ta_2O_5 and Al_2O_3.

having a refractive index of 2.12 and a dielectric constant of 22.1. (auth)

23470 SINTERING OF BOUNDARY POROSITY IN WELDED NIOBIUM BICRYSTALS. Vardiman, R. G.; Achter, M. R. (Naval Research Lab., Washington, D. C.). J. Less-Common Metals; 20: 281-90(Apr 1970).

An analogy is drawn between void shrinkage in the final stage of sintering and the elimination of porosity in the boundary of a welded bicrystal. Niobium bicrystals of zero degree and 35 to 50° misorientation were made, and annealed at temperatures of 1650 to 2000°C. A high, initial sintering rate decreased rapidly to a low, constant rate in the time interval in which excess dislocations climbed to an equilibrium configuration. This initial rate was strongly dependent on weld pressure. It is inferred that dislocations are the predominant vacancy sinks in shrinking the boundary voids. No effect of boundary misorientation was observed. (auth)

23471 THERMALLY ACTIVATED IMPURITY EFFECTS IN THE DEFORMATION OF TANTALUM. Pink, E. (Univ. of Maryland, College Park). Planseeber. Pulvermet.; 17: 262-9 (Dec 1969). (In German).

Irregularities in the temperature and strain rate dependency of mechanical properties are investigated between 0 and 800°C. They are explained as Cottrell and Snoek effects, caused by the interstitial atoms oxygen, carbon and nitrogen. The occurrence of serrated yielding is discussed with respect to the other effects. (auth)

23472 INVESTIGATION OF THE EFFECT OF DIFFUSION PROCESSES ON SINTERING OF METAL POWDERS. COMMUNICATION I. Fedorchenko, I. M.; Ivanova, I. I.; Fushchich, O. I. Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 30-6(Jan 1970). (In Russian).

The diffusion in powdered Fe–Cu systems was studied by microspectral analysis at 850 and 1000° and that in the Fe–Co systems at 850 and 1200°C. The intensity of the diffusion processes was shown to depend considerably on the distortion of crystalline lattice of powders and on metal deformation during pressing. Because of the considerable activity of boundary processes, the transfer of material in the powdered systems can be determined in some cases by the boundary diffusion. (auth)

23473 EFFECT OF GRAIN STRUCTURE ON THE FRACTURE OF RECRYSTALLISED TUNGSTEN WIRE. Forster, R. H.; Gilbert, A. (University Coll., Swansea, Eng.). J. Less-Common Metals; 20: 315-25(Apr 1970).

Bend tests on commercially-pure tungsten wire recrystallized at different temperatures to produce a range of grain structures are described. Although the conventional ductile-to-brittle transition temperature was higher for coarse than for fine grain material, the former can, nonetheless, tolerate the greater pre-yield strain prior to fracture initiation in the brittle range. This observation is thought to account for the increase in brittle fracture stress with an increase in grain size. For uniformly recrystallized specimens, the temperature dependence of the brittle fracture stress was much lower than that of the conventional yield stress. In contrast, the temperature dependence of the brittle fracture stress for specimens having a non-uniform grain structure was similar to that of the conventional yield stress. An attempt is made to rationalize these observations in terms of the unusual recrystallization behavior of the test material. (auth)

23474 INVESTIGATIONS ON THE DECARBURIZATION OF CARBON-CONTAINING MOLYBDENUM IN THE SOLID STATE. Kunze, J.; Reichelt, W. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). J. Less-Common Metals; 20: 327-38(Apr 1970). (In German).

Traces of carbon can be removed from molybdenum by heating moist hydrogen. A thermodynamic consideration of the equilibrium between the gas phase and the carbon-containing metal demonstrated that the carbon content could be reduced to a value in the ppB range. An experimental test using radioactive carbon showed that a residual carbon content lower than the detection limit of 0.1 at. ppM could be reached. The rate of decarburization was determined by the diffusion of carbon in a mixture of 100 torr hydrogen and 5 torr water vapor in the temperature range between 1345 and 1760°C. The measured diffusion coefficients can be described by the equation $D = 4.0 \times 10^{-2} \exp(-39300/RT)$. (auth)

23475 SOLID SOLUTION HARDENING OF TANTALUM BY NITROGEN AND OXYGEN. Puhr-Westerheide, J.; Elssner, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 20: 371-4(Apr 1970).

The applicability of the Frank theory to bcc metals with high interstitial impurity contents was investigated. Tantalum specimens with varying nitrogen and oxygen contents in solid solution were deformed in tension at –60 to +90°C at a strain rate of 4.27×10^{-4} sec^{-1}. In tantalum, nitrogen exhibited a higher hardening effect than oxygen. The lower yield stress varied linearly with the interstitial gas concentration except at very low gas contents and this variation was practically independent of the deformation temperature. A temperature dependent mechanism also contributed to the yield stress. (G.M.C.)

23476 INFLUENCE OF A THREE-STAGE HEAT TREATMENT ON THE MECHANICAL PROPERTIES OF A NEWLY DEVELOPED WELDABLE STEEL. Born, Kurt; Haarmann, Klaus (Thyssen Rohrenwerke AG, Mulheim, Ger.). Metal Constr. Brit. Weld. J.; 2: 61-4(Feb 1970).

Possibilities are discussed for improving the brittle behavior of known steels for nuclear power plants through a three-stage heat treatment. Tests were made to determine the influence of the chemical composition on the results of this heat treatment, and a steel was developed from this work, having a high yield point at elevated temperatures and very good low-temperature toughness. Weldability tests were carried out with electrodes and wire–powder combinations, while taking into account various heat treatment conditions. Finally, tests were conducted to discover how this three-stage heat treatment improved the toughness quality of the steel. (auth) (UK)

23477 FATIGUE OF METALS IN LIQUID METAL ENVIRONMENTS. Beddow, J. K. (Univ. of Iowa, Iowa City). pp 263-71 of Recent Advances in Engineering Science. Vol. 4. /Eringen, A. C. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From 5th Meeting on Recent Advances in Engineering Science, Huntsville, Ala. See CONF-671091.

Uniaxial push-pull fatigue tests of mild steel in contact with sodium at 500°C have shown that the endurance limit is reduced by as much as 30% due to the presence of the liquid metal. The path of main fracture is transgranular. Increasing the carbon content of steel reduces the percentage lowering of the endurance limit due to the sodium. It is suggested that this process is analogous to conventional corrosion fatigue and that it may be due to the presence of entrapped and combined oxygen in the liquid metal. Sodium has no effect on the S-N curve of stainless steel at 500°C. The effect of mercury on copper is negligible at the endurance limit. However, at higher stresses the S–N curve is pulled to lower values of N cycles to failure by the presence of the mercury. Fracture is by grain boundary cracking. The mechanism of fatigue failure in this case is ascribed to the strain activated diffusion of mercury down the grain boundaries of the copper. If the copper is alloyed with zinc, the detrimental effect of the mercury increases because the endurance limit is reduced progressively with increasing zinc content of the brass. Uniaxial push-pull fatigue tests on leaded and unleaded 60–40 brass have shown that liquid lead has a detrimental effect upon brass. This effect increases with increasing temperature. The main fracture follows the α and α/β boundaries. Finally the work reported here is correlated with results which have been obtained by other workers in this field. (auth)

23478 DIFFUSION OF COBALT IN BETA-URANIUM. Dariel, M. P.; Blumenfeld, M.; Kimmel, G. (Nuclear Research Centre, Negev, Israel). J. Appl. Phys.; 41: 1480-3(15 Mar 1970).

The solute diffusion of cobalt in beta-uranium was measured using the thin-layer sectioning technique. The results can be expressed by $D = 1.54 \times 10^{-2} \exp(-27{,}450/RT)$ cm^2/sec. The diffusivities of cobalt are higher by about three orders of magnitude than the self-diffusion coefficients in beta-uranium. The possibility of cobalt diffusing by means of the combined substitutional–interstitial mechanism has been examined. (auth)

23479 A URANIUM ALLOY WITH A LOW MOLYBDENUM CONTENT. Lerouge, Georges (to Commissariat a l'Energie Atomique). British Patent 1,188,739. 22 Apr 1970. Priority date 11 Aug 1967, France.

Improved uranium-base alloys are described. The basic alloy consists of 0.15 to 0.8 wt % Mo and 0.02 to 0.15 wt % of Si or Sn. A modified alloy contains in addition to the basic constituents, 0.02 to 0.2 wt % Al and/or 0.02 to 0.08 wt % Cr. (J.R.D.)

23480 SCATTERING OF LOW-ENERGY ELECTRONS FROM HYDROGEN-COVERED Mo(100) SURFACES. Dooley III, George J.; Haas, T. W. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). J. Chem. Phys.; 52: 993-6(15 Jan 1970).

Hydrogen has been found to adsorb onto the Mo(100) surface at room temperatures in two states. The first gives rise to LEED patterns with extra-order beams. The second structure arises from full monolayer coverage and gives only integral order spots.

The full coverage structure is easily electron-beam desorbed to give the lower coverage structure. (auth)

23481 PROCEEDINGS OF THE 16th NATIONAL SYMPOSIUM OF THE AMERICAN VACUUM SOCIETY INCLUDING THE SYMPOSIA OF THE THIN FILM AND SURFACE SCIENCE DIVISIONS, 28–31 OCTOBER 1969, SEATTLE, WASHINGTON. J. Vac. Sci. Technol.; 7: 1-288(Jan-Feb 1970). (CONF-691006).

Eighty-one articles are included; separate abstracts were prepared for 6. The remaining 75 papers contain information on surface science, thin film, and vacuum studies not in scope for NSA. (P.C.H.)

For abstracts of individual papers see: 22583, 22979, 23482–23484, and 23935.

23482 AUGER ELECTRON SPECTROSCOPY STUDY OF OXYGEN ADSORPTION ON W(110). Musket, Ronald G.; Ferrante, John (Louis Research Center, Cleveland). J. Vac. Sci. Technol.; 7: 14-17(Jan-Feb 1970).

From 16th National Vacuum Symposium, Seattle, Wash. See CONF-691006.

Quantitative oxygen coverage as a function of oxygen exposure was determined in an Auger electron spectroscopy study of oxygen adsorption on W(110). The oxygen Auger peak of the secondary electron energy distribution was resolved from the background, and the area of the peak was taken as proportional to the oxygen coverage. The initial slope of the coverage vs exposure curve provided a value of 0.23 ± 0.05 for the initial sticking coefficient. Comparison of the results with other studies is presented. (auth)

23483 CHEMISORPTION ON SINGLE CRYSTAL MOLYBDENUM(112) SURFACES. Dooley III, G. J.; Haas, T. W. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). J. Vac. Sci. Technol.; 7: 49-52(Jan-Feb 1970).

From 16th National Vacuum Symposium, Seattle, Wash. See CONF-691006.

Chemisorption trends established using LEED techniques have shown that, at least for tungsten and molybdenum, the most densely packed planes are not the most reactive. The body-centered cubic (110), (100), and (112) planes are the most densely packed in this system and they contain surface atoms in density ratios of 1.4 : 1.0 : 0.8. Adsorption studies on the molybdenum (112) plane were concerned mainly with O_2, N_2, H_2, and CO. Oxygen was the most reactive gas on this particular surface and formed (2 × 1), (2 × 1) + (1 × ?), (1 × 2), (1 × 3), and C(4 × 2) patterns. The (2 × 1), (2 × 1) + (1 × 2), and (1 × 2) coverages were obtained upon exposing the sample at room temperature to oxygen while the latter two patterns were obtained by heating the sample after very long oxygen exposures. No adsorption was found upon room temperature exposure to nitrogen while room temperature hydrogen exposure gave rise to a (1 × 2) LEED pattern. Carbon monoxide adsorbed only in an amorphous state at room temperature. Slight heating caused ordering of this amorphous structure resulting in complex LEED patterns. Changes in the intensity distribution of specularly reflected beams differed greatly depending on the gaseous species adsorbed. (auth)

23484 ARGON CONCENTRATION IN TUNGSTEN FILMS DEPOSITED BY dc SPUTTERING. Lee, William W.; Oblas, Daniel (General Telephone and Electronics Labs. Inc., Bayside, N. Y.). J. Vac. Sci. Technol.; 7: 129-33(Jan-Feb 1970).

From 16th National Vacuum Symposium, Seattle, Wash. See CONF-691006.

The relative argon concentrations of dc-sputtered tungsten films were determined as a function of argon pressure, target-to-substrate voltage, substrate bias, and target-to-substrate distance, for both the diode and triode configurations. The results for films sputtered in the diode mode supported Winters' and Kay's conclusions that the adsorption mechanism was due to entrapment of energetic neutral argon atoms. This model, however, did not apply for all the argon content in films sputtered in the triode mode. An additional mechanism resulting in a greater entrapment of argon is proposed, namely, the entrapment of low energy argon ions originating from the supporting glow discharge. Measurements of the argon content of the tungsten films were determined using the rf spark-source mass spectrograph. (auth)

Structure and Phase Studies

Refer also to abstracts 23766 and 24138.

23485 STRUCTURE AND CRYSTALLOGRAPHY OF THE EUTECTIC FOUND IN Ni–Ni_3Nb. Senicourt, Daniele; Annarumma, Pierre (Centre des Materiaux, Paris). Compt. Rend., Ser. C, 269: 591-4(Sept. 15, 1969). (In French).

The Ni–Ni_3Nb eutectic solidifies in the form of alternated lamellae of two phases. Parallel to the direction of growth, the dimensions of the lamellae are of several mm. The direction of growth of the two phases and their joining planes were determined by x-ray diffractometry and texture analysis. A precipitation at the interior of the nickel lamellae was identified as orthorhombic Ni_3Nb. (J.S.R.)

23486 NEUTRON-DIFFRACTION STUDY OF THE DECOMPOSITION AND ORDERING IN THE NIOBIUM–HYDROGEN SYSTEM. Somenkov, V. A.; Petrunin, V. F.; Shil'shtein, S. Sh.; Chertkov, A. A. Sov. Phys.-Cryst. (Engl. Transl.); 14: 522-30(Jan-Feb 1970).

Translated from Kristallografiya; 14: 617-28(Jul-Aug 1969).

A decomposition with a precipitation of partially ordered hydride ($NbD_{0.45}$) was observed in the solid solution of 3 at. % deuterium in niobium at 270°K. A further ordering occurred at 170°K. The structure of the ordered phase was determined to be Nb_4D_3. (auth)

23487 SCANDIUM AND YTTRIUM FILMS ON THE (100) FACE OF TUNGSTEN. Gorodetskii, D. A.; Yas'ko, A. A. (Kiev State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 2028-32(Mar 1970).

Translated from Fiz. Tverd. Tela; 11: 2513-19(Sep 1969).

The structures of scandium and yttrium films on the (100) face of tungsten were studied by slow-electron diffraction. During room-temperature deposition on the crystal, both metals monotonically decrease the work function and do not yield ordered structures. After heating, the scandium films form a c(2 × 2) structure, and probably a (1 × 1) structure. Scandium crystals of the β phase are observed to grow on the tungsten (100) face, with their (100) face parallel to the backing surface. In addition to the c(2 × 2) structure, the yttrium films form two structures, one of which gives a minimum work function for the surface. This structure has a lattice constant which is large in comparison with that of the backing and may form through penetration of additional yttrium atoms into the c(2 × 2) lattice. The results obtained for scandium and yttrium are compared with the structure of these metal films on the (110) face of tungsten and with the structure of thorium and barium films on the (100) face of tungsten. (auth)

23488 CRYSTAL CHEMISTRY OF LANTHANON ALLOYS. Pearson, W. B. (Univ. of Waterloo, Ont.). J. Metals; 22: No. 4, 51-5(Apr 1970).

The crystal structures adopted by lanthanon alloys are shown to derive their stability mainly from coordination and geometrical factors on the one hand, because of the relatively large size of the Ln atoms, and on the other hand from the chemical bond factor, because of their relatively high trivalency and electropositive character. Structural stability arising directly from the effects of electron concentration, such as is observed in alloys of Cu, Ag and Au with succeeding B Group metals, and in transition metal alloys, is likely to be unimportant in binary lanthanon alloys. (auth)

23489 INVESTIGATION OF Al-RICH PART OF THE Mo–Fe–Al SYSTEM. Markiv, V. Ya.; Burnashova, V. V.; Ryabov, V. R. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 1, 69-72(1970). (In Ukrainian).

The Al-rich part of the system Mo–Fe–Al was investigated by means of x-ray and microscopic analyses. The phase equilibria were established at 1050 and 800°C. At 1050°C two ternary phases (N and S) existed. Both phases were stable at a high temperature (N-phase decomposed between 900°C, S-phase existed between 1050 and 1000°C), N-phase was isotopic with $TiAl_3$ ($MoFe_{0.28}Al_{2.72}$, a = 3.767 Å, c = 8.43$_3$ Å, c/a = 2.24). The phase with the same structure was formed in the Mo–Co–Al system (a = 3.74 Å, c = 8.40 Å, c/a = 2.24). (auth)

23490 ELECTRICAL AND STRUCTURAL PROPERTIES OF CO-SPUTTERED TANTALUM–ALUMINUM FILMS. Steidel, C. A. (Bell Telephone Labs., Inc., Allentown, Pa.). J. Vac. Sci. Technol., 6: 694-8(July-Aug. 1969).

From International Conference on Thin Films, Boston, Mass. See CONF-690435.

Tantalum–aluminum alloy films have been prepared by dc diode sputtering in argon from composite cathodes of tantalum sheet, with either inlaid strips of aluminum or aluminum strips attached to the tantalum. The aluminum coverage of the tantalum cathode has been varied between 0 and 85%. The coverages produced films ranging from 0% to about 85% aluminum, which are homogeneous in composition as determined by electron microprobe analysis. The as-deposited films of pure tantalum have either the bcc or β–Ta structure. Both structures form metastable solid solutions with up to 20 at. % aluminum. At 30% aluminum a new phase very similar to β–Ta appears. Between 30 at. % and 85 at. % aluminum a number of phases have been observed in the sputtered films but of the known bulk phases of the tantalum–aluminum system, Ta_2Al,

$Ta_{17}Al_{12}$, $Ta_{13}Al_{17}$, and $TaAl_3$, only $TaAl_3$ is observed in the sputtered films at 85% aluminum. The dependence of the electrical properties of tantalum–aluminum films on aluminum concentration has been determined. These properties include resistivity, $d\rho/dT$, Hall coefficient, carrier concentration and type, and Hall mobility. Results on alloy films are compared to those reported for the bulk aluminides Ta_2Al and $TaAl_3$. (auth)

23491 IDENTIFICATION OF AN IMPURITY PHASE IN METASTABLE β-TITANIUM ALLOYS. Bowen, A. W.; Stubbington, C. A. (Royal Aircraft Establishment, Farnborough, Eng.). J. Less-Common Metals; 20: 367-70(Apr 1970).

TiC, an impurity phase, was observed in the grains and at the grain boundaries of a commercial Ti-15% Mo alloy quenched from temperatures above the β transus (>780°C). This is the first report of carbide precipitation in titanium alloys with about 0.2% C. Prolonged annealing allowed the carbide precipitation to proceed to completion. The effects of carbide precipitation on the tensile properties of the Ti–15% Mo alloy were investigated. Titanium carbide precipitation was also found in other β-Ti alloys: Ti-35% Nb; Ti-15% V; Ti-15% Cr; and Ti-61% Ta. (G.M.C.)

23492 CRYSTAL STRUCTURE OF SOME COPPER COMPOUNDS OF THE TYPE RCu_6. Buschow, K. H. J.; Van Der Goot, A. S. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals; 20: 309-13(Apr 1970).

A number of rare-earth–copper alloys and thorium–copper alloys near 86 at.% Cu were investigated by x-ray diffraction. It is shown that the compounds $ThCu_6$ and RCu_6, with R = Pr, Nd, Sm, Gd, are isotypic and have the orthorhombic $CeCu_6$ type of structure. For R = Tb and Dy no stable compound of this structure type exists. (auth)

23493 CALCULATION OF THE BOND ENERGY IN METALS. Rzyanin, B. F. Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 66-8 (Jan 1970). (In Russian).

The calculations of the bond energy and equilibrium interatomic distances in metals (K, Ca, Sc, Rb, Sr, Y, Zr, Nb, Cs, Ba, La) were continued using the model of free electrons and impenetrable ionic cores. The calculations were carried out on the Minsk-22 computer. The calculated data were in good agreement with the experimental data. The calculations of the compressibility were carried out also for the majority of the enumerated metals. The compressibility theoretical values corresponding to single crystals differ from the experimental data by 20 to 35%, obtained on semicrystalline samples. (auth)

23494 VOID FORMATION DUE TO THERMAL DIFFUSION IN SAMARIUM. Kumar, J.; Srivastava, Onkar N. (Banaras Hindu Univ., India). Z. Metallk.; 61: 287-8(Apr 1970).

Thin films of annealed samarium when subjected to temperature gradients exhibit voids. Evidence and arguments have been presented to show that the voids are formed due to condensation of vacancies resulting from thermal diffusion. It has been shown that void formation similar to those observed in bulk specimens can result also in thin films. (auth)

Radiation Effects

Refer also to abstracts 23535, 24122, and 24875.

23495 (AECL-3516) METALLURGICAL PROPERTIES OF COLD-WORKED ZIRCALOY-2 PRESSURE TUBES IRRADIATED FOR FIVE YEARS IN THE NPD REACTOR. Langford, W. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1970. 32p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Zircaloy-2 pressure tubes were irradiated to a maximum neutron dose of 1.2×10^{21} n/cm² (>1 MeV) at 10,500 psi hoop stress in the Nuclear Power Demonstration Reactor (NPD). Post-irradiation examination showed that mechanical strength increased and ductility decreased as a result of the reactor service. The tubes can sustain a 4 in. axial slit at operating stress without catastrophic propagation of the slit, ensuring that coolant leakage would precede catastrophic tracture. Maximum deuterium uptake was 9 ppM per annum. The rolled joints at the tube ends were sound, and showed no evidence of leakage or corrosion. All measured properties were consistent with requirements for a pressure tube life of 30 years. (auth)

23496 (ANL-7259) THORIUM–URANIUM–PLUTONIUM ALLOYS AS POTENTIAL FAST POWER-REACTOR FUELS. PART II. PROPERTIES AND IRRADIATION BEHAVIOR OF THORIUM–URANIUM–PLUTONIUM ALLOYS. Blumenthal, B.; Sanecki, J. E.; Busch, D. E.; O'Boyle, D. R. (Argonne National Lab., Ill.). Oct 1969. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

Thorium-uranium-plutonium alloys with 10 to 20% uranium and 10% plutonium were evaluated for potential usefulness as fast reactor fuels at typical fast reactor operating temperatures. Irradiation tests in CP-5 showed that 5.6 at. % burnup of heavy metal atoms (Th + U + Pu) did not appreciably affect the original microstructure of the fuel. Fuel swelling, measured after irradiation, was about 7.3% per atomic percent burnup, and 70% of the fission gas was released into the plenum. The alloys, which were prepared by arc-melting and tilt-pour casting from metals of commercial purity, could be hot rolled at 450°C in a glovebox with a nitrogen atmosphere without additional protection. The hardness, compressive strength, density, coefficient of thermal expansion, and thermal conductivity were measured for each alloy, and appropriate functions are reported. The alloys were found to be compatible with vanadium-base cladding materials, but not with stainless steel. The alloys compared favorably with other metal fuels in thermal-cycling experiments. Included in the results of this study are density data for a series of binary Th–U alloys with up to 50% uranium, binary Th–Pu alloys with up to 60% plutonium, and two ternary series of Th–U–Pu alloys with 2 and 4% uranium; also reported are electrical resistivity measurements on a Th-30% Pu alloy. (auth)

23497 (BNWL-1279, pp 4.1-117) IRRADIATION DAMAGE TO REACTOR METALS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Research and development progress is reported on irradiation behavior of structural materials, radiation effects on fuel subassembly materials, and characterization of materials for fast reactors. (J.R.D.)

23498 (BNWL-tr-46) STUDY OF THE SWELLING OF URANIUM ALLOYS UNDER IRRADIATION. Lehmann, J.; Paoli, P.; Azam, N. Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from J. Nucl. Mater.; 27: 285-309(1968). 43p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 49778.

23499 (IN-1359) THE EFFECT OF HYDROGEN ON DUCTILE PROPERTIES OF IRRADIATED PRESSURE VESSEL STEELS. Brinkman, C. R.; Beeston, J. M. (Idaho Nuclear Corp., Idaho Falls). Feb 1970. Contract AT(10-1)-1230. 64p. Dep. CFSTI.

The influence of hydrogen on the mechanical properties (i.e., ductility, fracture strength, and tendency towards delayed failure) of several irradiated pressure vessel steels was investigated. Included in this investigation were ASTM A302B, A542, and HY-80 steel irradiated at or to fluences of from 8×10^{18} to 4×10^{20} n/cm² E > 1 MeV. Specimens were prepared and tested from plate sections of these steels which were quenched and tempered and some from A542 which were given prestrain and heat-treatment modifications. The effects of strength level from irradiation, heat treatment, and microstructure were thus determined. Reductions in ductility and true fracture strength occurred with increasing hydrogen content but were not extensive at strength levels less than 180 ksi in specimens containing 1 to 2 ppM hydrogen. This concentration, however, produced a marked effect on the ductile properties when the strength level was increased by irradiation hardening or heat treatment beyond this threshold range. Irradiation hardening increased the magnitude of the decrease in notched strength resulting from a given hydrogen content in all of the steels and conditions tested. Hydrogen-induced delayed failure, however, did not occur to any large extent in HY-80, A302B, and A542 steel in the normal quenched and tempered condition even after irradiation to fluences in excess of 10^{20} n/cm² E > 1 MeV and hydrogen concentrations of up to 4 ppM. (auth)

23500 A QUANTITATIVE STUDY OF THE DOSE AND IMPURITY DEPENDENCE OF THE DEFECT CONCENTRATIONS REMAINING IN MOLYBDENUM AFTER 4 MeV ELECTRON IRRADIATION AT (77°K). Evans, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Acta Met.; 18: 499-504(May 1970).

Experimental measurements using resistivity techniques to follow the increase of defect concentration with electron irradiation dose were made on high purity molybdenum and molybdenum doped with nitrogen to two different levels. The marked dependence of defect concentration on impurity could be satisfactorily explained by the Walker model which assumed that the interstitial defect was mobile at the irradiation temperature and that the retention of the interstitial depended on it being trapped at an impurity sink rather than annihilated at a vacancy. It appeared therefore that the interstitial defect was mobile in molybdenum at 77°K. This result is in direct contrast to other authors who deduced from their work that the interstitial did not become mobile until Stage III. Evidence is presented to show that their

results are in fact compatible with the Walker model and the implication of the present work on Stage III annealing in molybdenum is discussed. (auth)

23501 IRRADIATION OF STRESSED PRESTRESSING WIRE COATED FOR CORROSION PROTECTION. Hildebrand, J. F. (Gulf General Atomic Inc., San Diego, Calif.). Mater. Protect.; 9: 19-22(Mar 1970).

In prestressed concrete reactor vessels, tendons may need periodic inspection and may be exposed to irradiation. Corrosion protection by means other than grouting must be provided if the tendons are to be inspected. Petroleum based corrosion inhibiting compounds break down under irradiation, and the hydrogen produced may embrittle the highly stressed wire. Notched tendon wire specimens stressed at 75% of their notched ultimate tensile strength and coated with corrosion inhibiting compounds were exposed to irradiation in a Triga reactor. Fluences of 1.3×10^{17} n/cm^2 (E > 1 MeV) and gamma doses of 4.2×10^9 rads did not cause hydrogen embrittlement or degradation of the steel tendon wire. (auth)

Ceramics and Cermets

Refer also to abstracts 22665, 23425, and 24784.

23502 (BMI-1830) DEVELOPMENT OF ADVANCED HIGH-TEMPERATURE NUCLEAR MATERIALS DURING NOVEMBER 1967-JANUARY 1968. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). 1 Feb 1968. Contract W-7405-eng-92. 106p. Dep. CFSTI.

Examinations of UC and UN specimens irradiated at temperatures near 1680°C to burnups up to 2.5×10^{20} fissions per cm^3 and after diameter increases of 17 and 10%, respectively, disclosed that the porosity in the UC is largely in the form of discrete spherical bubbles, whereas the porosity in the UN is largely in the form of elongated, interconnected channels. Considerable transport of UN by sublimation was observed; this transport mechanism may be responsible for many of the redeposited, gas-bubble-free regions of UN grains observed near the central axis of the fuel and for columnar grains observed near the cladding. This difference in structure and behavior is believed to be responsible for the as yet unconfirmed differences in gas release between UC and UN and for the much more pronounced saturation of swelling in UN as compared with UC. Saturation of swelling in a tungsten-50 vol % UO_2 cermet after 17 percent diametral expansion at 1775°C was associated with gross tearing of the cermet matrix throughout much of its volume, especially in regions more than 0.030 in. from the cladding. Some vapor transport of UO_2 from the fragmented zone to the gas plenum was noted. At a burnup of 2.0×10^{20} fissions per cm^3 at about 1700°C, a 0.110-in. axial centerline hole was definitely detrimental and a 0.055-in. hole had no significant effect on UC, whereas a 0.055-in. hole apparently reduced the swelling of UN. This behavior is consistent with observations of bubble morphologies in these types of fuels. At a burnup of 0.9×10^{20} fissions per cm^3 at about 1700°C, UO_2 vented by a 0.110-in. axial centerline hole swelled 15 vol %. In a contrary manner, UO_2 vented by a tapered metal tube at its axis swelled only 3 vol %. Two UC-copper cermets remained intact after a burnup of 0.7×10^{20} fissions per cm^3 at about 1500°C. The diametral strain of these specimens was less than 3 percent. Two 72 percent dense tungsten-70 vol % UO_2 cermets apparently densified further by sintering during one cycle of irradiation at about 1600°C. It was found possible to fabricate a tungsten-UN cermet containing about 25 vol % porosity by decomposing U_3N_5 in the cermet after hot pressing. The resultant structure resembled an irradiated structure after saturation of swelling to the extent that the majority of this porosity was surface connected. Fission-gas-release measurements from UC irradiated to 6×10^{18} fissions per cm^3 suggested that the gas exists in metastable, supersaturated solid solution in this material at this exposure level, and that the gas precipitates from solution on annealing for long times at 1300°C or for short times at 1700°C. Models of nuclear fuels suggested that bubbles can begin to overlap, producing gas release channels at volume increases of 14 to 27 percent. Assuming that tearing between bubbles occurs long before overlap, decreasing strength of the fuel and gas release are expected at much lower volume increases. Incorporation of simultaneously decreasing strength and increasing gas release into the mechanical model for the swelling behavior of a nuclear fuel causes it to conform closely to the observed behavior of fuels irradiated on this program. (auth)

23503 (BMI-1879) PROGRESS ON HIGH-TEMPERATURE FUELS TECHNOLOGY DURING NOVEMBER 1969-JANUARY 1970. Keller, Donald L.; Chubb, Walston (Battelle Memorial Inst., Columbus, Ohio). Feb 1970. Contract W-7405-eng-92. 79p. Dep. CFSTI.

Columnar grains 25 to 50 μ wide and 100 to 1000 μ long were observed from the centerline to the cladding of a UO_2 specimen which operated at a maximum surface temperature of 1555°C. This specimen released approximately 90 percent of its fission gas and swelled approximately 10 vol %. UO_2 specimens operating at higher surface temperatures (1600 to 1900°C) showed similar columnar grain structures and similarly high gas releases, but the rate of swelling increased rapidly as the temperature increased. Columnar grains 20 to 40 μ wide and 40 to 60 μ long were observed from the centerline to the cladding of a UO_2 specimen which operated at a maximum surface temperature of 1360°C. This specimen released approximately 75 percent of its fission gas and swelled approximately 5 vol %. The amounts of swelling observed correlate neither with gas pressures measured inside claddings nor with the thermal cycling history of the UO_2 specimens, so it is concluded that the external swelling of these elements is caused by the growth of fission-gas bubbles within the UO_2. The swelling of UN at temperatures near 1600°C was observed to take place primarily by the development of porosity at the grain boundaries. The porosity at the grain boundaries was associated with a very small fraction of the gas (perhaps as little as 4 percent) in the UN. This result helps to explain the low swelling rates achieved previously in UN specimens containing interconnected porosity. Results of studies of bubble populations in lightly irradiated and annealed UC indicate that there are two distinct distributions of bubble sizes present. One distribution has a mean bubble size much larger than the other, and these larger bubbles seem to be most frequently associated with grain boundaries. A 60 percent dense specimen of crushed, minus 230-mesh particles of UC showed a volume change of 7 percent after a burnup of 2×10^{20} fissions per cm^3 at 1530°C. This result compares favorably with volume increases of about 35 percent at the same burnup at 1680°C in dense UC. The postirradiation structure of the 60 percent dense specimen suggests that the lack of interparticle contacts was the major factor in eliminating swelling during the first half of the irradiation, and that growth of these contacts by vapor transport and sintering led to a gradual increase in swelling rates during the last half of the irradiation. The vapor pressure of plutonium over carbon-rich UC-20 wt % PuC is more than four orders of magnitude greater than that of uranium over carbon-rich UC. A creep test of tungsten-26 wt % rhenium under conditions of continuously increasing loads corresponding to stresses produced by 100 percent gas release from a specimen containing fuel at 1700°C has indicated that the deformations expected from gas release are negligible at burnups of the order of 3×10^{19} fissions per cm^3, but that gas pressures from released gas can become significant at higher burnups depending upon the void volume available. (auth)

23504 (BNWL-1279) REACTOR FUELS AND MATERIALS DEVELOPMENT PROGRAMS FOR FUELS AND MATERIALS BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. Quarterly Progress Report, October-December 1969. Sheely, W. F. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 267p. Dep. CFSTI.

Research and development progress is reported in eight sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 22847, 22915, 23497, 23505, and 23533-23536.

23505 (BNWL-1279, pp 2.1-26) FAST REACTOR CERAMIC FUELS RESEARCH. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Research and development progress is reported on high-temperature creep of UO_2-20 wt % PuO_2, properties of fast reactor oxide fuels, in-pile creep of UO_2-25 wt % PuO_2, hot pressing of fast reactor ceramic oxides, phases in mixed oxides, thermal expansion of mixed oxides, and electron microscopic investigations of fuels. (J.R.D.)

23506 (WARD-4135-4) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1969. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb 1970. Contract AT(30-1)-4135. 109p. Dep. CFSTI.

Activities in a program involving parallel analytical and experimental studies on mixed oxide fuel pins are reported. Progress is reported on fuel performance analysis, improvement of analytical methods and fuel lifetime codes, encapsulated mixed oxide fuel pin irradiation tests, mixed oxide irradiation tests in grid-type subassemblies, pin grid-type fuel assembly design and development, development of LMFBR fuel assemblies, fabrication of EBR-II subassemblies, pellet fabrication, fabrication of irradiation test fuel pins, and quality control. (J.R.D.)

Corrosion and Erosion

23507 ALLEVIATION OF THE SILICIDE PEST IN A COATING FOR THE PROTECTION OF REFRACTORY METALS AGAINST HIGH-TEMPERATURE OXIDATION. Falco, J. J.; Levy, M. (Army Materials and Mechanics Research Center, Watertown, Mass.). J. Less-Common Metals; 20: 291-7(Apr 1970).

Studies of the mechanisms of protection and failure of a modified disilicide coating for a 90 Ta–10W alloy have evolved a simple method for alleviating the silicide pest by a preoxidation treatment. (auth)

23508 HIGH-TEMPERATURE X-RAY DETERMINATION, IN A CONTROLLED ATMOSPHERE, OF THE PARAMETERS OF UO_{2+x} AND U_4O_{9-y}, AS A FUNCTION OF THE COMPOSITION. Touzelin, B.; Dode, M. (Faculte des Sciences, Orsay, France). Rev. Int. Hautes Temp. Refract.; 6: 267-74(Oct–Dec 1969). (In French).

The progressive oxidation of UO_2 in an atmosphere with a determined amount of oxygen was followed by high temperature x-ray diffraction, till the appearance of U_3O_8. The relation between parameters and composition was determined from the nature of the stable phase at a precise oxygen pressure. It was established that in the U, O, system the U_4O_9 phase disappeared at 1,125°C but this phase was still observed by x-ray investigation at 1,150°C, before the formation of U_3O_8. It is probably a metastable state. (auth)

Preparation and Fabrication

Refer also to abstracts 22622, 22735, 22736, 22881, 22889–22891, 23436, 23446, and 23447.

23509 (EUR-4389) THE PREPARATION OF UO_2–PuO_2 POWDERS BY CO-PRECIPITATION AND THE MANUFACTURE OF HIGH-DENSITY PELLETS. Zamorani, E.; De Rijk, J.; Dhoop, G.; Schoenherr, H. (European Atomic Energy Community, Karlsruhe (West Germany). European Transuranium Inst.). 3 Sep 1969. 24p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 4,45.

UO_2–PuO_2 pellets with a density of over 90% of theoretical (t.d.) in solid solution were obtained with plutonium concentrations of less than 45%. The influence of the precipitation conditions and temperature, the calcination and reduction temperatures, and the compacting pressure on the final density of the sintered material was examined with the aim of applying this method to powders with a higher plutonium concentration. The influence of the calcination/reduction temperature and compacting pressure on the density before and after sintering was studied. According to the results of the experiments, the density after calcination is not significantly affected by these two variables when the calcination/reduction temperature is over 500°C. The crushing process necessary when the precipitation is carried out, even at 80°C, was avoided by neutralizing the nitric acid solution of Pu^{4+} and UO_2^{2+} at 95°C. The precipitate was calcined at 900°C in air and reduced at 600°C in N_2–8% H_2. The same atmosphere is used for the sintering of pellets at a temperature of 1600°C. This method has the advantage of producing: an easily filtered precipitate, a very fluid powder with a specific surface of 2 to 5 m^2/g, high-density pellets (90% of t.d.) with plutonium concentrations of between 5 to 97%, and a very good homogeneity at all concentrations according to α-autoradiographs and x-ray spectrometry. (auth) (EURATOM)

23510 (ORNL-4531) MINIMIZING THERMAL EFFECTS IN FLUIDIZED-BED DEPOSITION OF DENSE, ISOTROPIC PYROLYTIC CARBON. Beatty, R. L.; Scott, J. L.; Kiplinger, D. V. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 30p. Dep. CFSTI.

High-density isotropic pyrolytic carbon coatings on ceramic fuel microspheres can be deposited from propane at much lower temperatures and at higher rates than from methane, but the high heat capacity and heat of formation of propane would complicate heat supply to a large-scale coater. Deposition from propane and propene (which has smaller heat requirements) at 1150 to 1300°C with fluxes varied by dilution with helium were compared. Either gas undiluted gave coatings denser than 2.0 g/cm^3 at 1250°C at 10 μm/min. Propyne and propadiene gave similar coatings more rapidly, and with no heat requirement, but the range of conditions was limited by the instability of these gases, and the coatings were less dense than those derived from propane or propene under similar conditions. (auth)

23511 (PEL-195) THE FABRICATION AND PROPERTIES OF URANO–URANIC OXIDE (U_3O_8). Schaekers, J. M.; Lovell, G. H. B. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Dec 1969. 10p. Dep. CFSTI (U. S. Sales Only).

Urano-uranic oxide was fabricated both by slip casting and by die pressing, followed in each case by sintering at temperatures up to 1400°C. High densities were achieved and lining bricks measuring 10.2 × 5.8 × 1.3 cm were produced. These are being considered for forming corrosion-resistant linings in vessels used for high-temperature uranium processing. The material was brittle, had a Vickers hardness of 488, modulus of rupture of 164 kg cm^{-2} and on heating to 450°C shrunk linearly by about 0.1% followed by a slight expansion on further heating, recovering its original length at about 800°C. It possessed high resistance to thermal cycling and thermal shock, and had a thermal conductivity of 0.0058 cal cm^{-1} sec^{-1} $°C^{-1}$ when measured on a porous disc, 85% of theoretical density. (auth)

23512 A PROCESS FOR THE PRODUCTION OF PARTICLE-FILLED FUEL RODS. (to Nuklear-Chemie Und-Metallurgie GmbH). British Patent 1,185,940. 25 Mar 1970. Priority date 15 Nov 1967, Germany.

A process for production of clad fuel rods loaded with particulate oxides, carbides, or nitrides of fissile or fertile elements is described. The particles are introduced into the fuel cans in vacuo from adsorbed gases and vapors. A dry nontoxic gas is used as the working atmosphere and is pumped off just prior to introduction of the fuel into the cans. (J.R.D.)

23513 TERNARY NITRIDES OF SOME ALKALINE EARTH METALS WITH MOLYBDENUM AND TUNGSTEN. Karam, Ronald Edward. Storrs, Conn.; Univ. of Connecticut (1969). 108p.

Thesis.

Ternary nitrides of some alkaline earth metals with molybdenum and tungsten were synthesized. A calcium molybdenum nitride phase corresponding to the formula $Ca_{26}Mo_4N_{26}$ (Ca_6MoN_6) was synthesized at 950°C. This phase was indexed on the basis of a hexagonal unit cell (a = 11.4 Å and d = 7.45 Å). This compound was an insulator at room temperature and showed temperature independent paramagnetism. An analogous calcium tungsten nitride phase was formed at 850°. This compound appeared to be structurally and stoichiometrically equivalent to calcium molybdenum nitride. $Sr_{27}Mo_4N_{26}$ was synthesized at 750°. The powder pattern of this compound was indexed on the basis of a cubic unit cell (a = 5.25 Å) and appeared to be identical to that of $Sr_{27}Re_4N_{24}$. $Sr_{27}W_4N_{24}$ was synthesized at 800° and appeared to be identical in every way to $Sr_{27}Mo_4N_{24}$. This compound was found to be diamagnetic. Higher temperature phases for both the Sr–Mo–N and Sr–W–N systems were found but were not characterized. A form of β molybdenum nitride ($Mo_{22}N_{14}$) was found which was stable at room temperature. The synthesis was carried out by heating (750°) molybdenum metal in nitrogen in the presence of a small amount of calcium nitride. The powder pattern of this compound was indexed on the basis of a tetragonal unit cell (a = 8.414 Å, c = 8.050 Å). The structure is thought to be of the sodium chloride type with nitrogen vacancies. (Diss. Abstr.)

23514 FABRICATION OF URANIUM MONOSULFIDE. Mukaibo, Takashi; Kanno, Masayoshi; Nakai, Eiichiro; Kokubo, Sanya (Mitsubishi Metal Mining Co., Ltd.). Nippon Genshiryoku Gakkaishi; 12: 110-15(1970). (In Japanese).

Uranium sulfide, one of the potential high-temperature nuclear fuels, was prepared by the reaction of uranium with H_2S gas followed by homogenization at high temperature. Resulting powders of two different grain sizes (specific surface area of 0.37 and 0.62 m^2/g) were separately sintered at 1,400 to 2,000°C in vacuum. Sintering was found to proceed above 1,400°C, and with a sintering temperature of 1,750°C and compacting pressure of 4 t/cm^2, products of 88 to 91% theoretical density were obtained with the 0.37 m^2/g powder and 94 to 97% theoretical density with the 0.62 m^2/g powder. A discussion is given of the effect on densification brought by differences in compacting pressure, in temperature and duration of sintering, and in heating rate. The microstructures of the sintered bodies were observed by microscope, and the average grain size, shrinkage and Vickers hardness were determined. It was found that UOS, contained as an impurity in the US, contributed to producing high-density sintered US. (auth)

23515 PREPARATION AND SOME CHARACTERISTICS OF SELF-SUPPORTING 300 TO 2500-A OXIDE FILMS. Aladjem, A. (Soreq Research Center, Yavne, Israel); Brandon, D. G. J. Vac. Sci. Technol., 6: 635-7(July-Aug. 1969).

From International Conference on Thin Films, Boston, Mass. See CONF-690435.

An improved technique for the preparation of Ta, Nb, W, Ti, and Zr oxide films is described. Foils of the respective metal are anodically oxidized to the required thickness; by suitable masking, a non-oxidized area (with the exact shape and area of the desired "window") is left on one side of the foil. The mask is removed and the metal is dissolved by making the foil the anode in an electrolyte

consisting of an NH, Cl solution in methanol or in ethylene glycol. Self-supporting films, with a surrounding frame of residual metal and with an area up to 12 mm have been prepared by this technique. The films are pore-free, of adequate mechanical strength, and exhibit a high resistance to radiation damage when irradiated by alpha and beta particles. (auth)

23516 STRAIN HARDENING IN POLYCRYSTALLINE NICKEL CONTAINING A DISPERSION OF THORIA. Durber, G. L. R.; Davies, T. J. (UMIST, Manchester, Eng.). Mater. Sci. Eng.; 5: 142-8(1969-70).

Strain hardening characteristics of polycrystalline nickel containing a disperse phase of thoria have been examined. Alloys containing up to 3 vol % of dispersant were prepared by sequentially powder blending, hot compacting and wire swaging. Room temperature tensile tests and cyclic temperature tests (Cottrell–Stokes analysis) between 77 and 293°K were carried out on a Polanyi-type attachment. The flow stress was found to increase with decreasing interparticle spacing as predicted by theory. The flow stress/interparticle spacing relationships were found to be in good agreement with Ashby's theory of strengthening, assumption having been made for the polycrystallinity of the material. The presence of a disperse inert phase is considered to decrease the temperature sensitivity of the flow stress. (auth)

23517 DEVELOPMENT AND RESEARCH OF NEW REFRACTORY MATERIALS. Heat Transfer - Sov. Res.; 2: 124-7(Mar 1970).

Development of processes for production of refractory and insulating materials is described. Studies on ZrO_2-base electrode materials for MHD generators were conducted along with investigations of structure changes in Y_2O_3-stabilized ZrO_2 at 1900 to 1950°C. Other investigations are reported on SiC-base cermets with Ti, Mo, and Cr. Research on magnesium and aluminum concretes for MHD uses are reviewed. (J.R.D.)

Properties Evaluations

Refer also to abstracts 23431 and 23469.

23518 (AD-698327) ADVANCED METALLIC MATERIALS FOR AEROSPACE APPLICATIONS. Report for January–June 1968. Stanley, James K.; Smallen, Harold (Aerospace Corp., El Segundo, Calif.). 22 Sep 1969. Contract F04701-69-C-0066. 74p. (TR-66(5250-10)-3; SAMSO-TR-69-355). CFSTI.

The low weight and high strength of composites, titanium alloys, superalloys, refractory metals, and beryllium make them useful for construction of aerospace vehicles. Present and projected uses of these materials for aerospace structures are discussed. (auth) (USGRDR)

23519 (AERE-R-6149) SOME MECHANICAL PROPERTIES OF CARBON FIBRE COMPOSITES. Wells, H.; Colclough, W. J.; Goggin, P. R. (Atomic Energy Research Establishment, Harwell (England)). Jul 1969. 53p. Dep. CFSTI (U. S. Sales Only). UK 9s.

Results of experiments are reported which indicate that given improvements in the technology of composite manufacture such as tow or tape winding, and the preparation of sheet material to achieve more precise filament orientation, materials can be produced with mechanical properties which will agree substantially with those predicted by micromechanics. Some of the methods of tests currently used will have to be re-examined when used with carbon composites. High performance resins are likely to attract increasing attention because of the increase in transverse properties notably the elastic constants and possibly in impact resistance. Glass fiber resin composites are now universally accepted as high strength structural materials. This is because of improvements in glass fiber resin systems and coupling agents; it is also because workers in many countries have contributed to a better understanding of the strength characteristics of duplex materials. To ensure a similar acceptance of carbon fiber composites it is important that supplies of fiber should be readily and commercially available as soon as possible to obtain the type of data referred to above. (auth)

23520 (HIT-421) HIGH TEMPERATURE METAL THERMAL SWITCH DEVELOPMENT PROGRAM. Quarterly Report No. 1, July–September 1969. (Hittman Associates, Inc., Columbia, Md.). Mar 1970. Contract AT(29-2)-2797. 20p. Dep. CFSTI.

Activities in the first three months of the effort performed under the High Temperature Metal Thermal Switch Development Program are summarized. A thermal model of a typical high temperature heat source has been formulated to evaluate potential thermal switch composites for reentry protection effectiveness. A total of 11 computer runs has been made on various composite materials. In general, all materials appear effective in protecting the heat source from earth orbital reentry. Alumina (Al_2O_3) and zirconia (ZrO_2) were selected for the ceramic foam material to be used for metal impregnation and thermal switch studies. Low density ceramic foams of these oxides will be made by a burn-out technique. The variables: density; pore size; stabilization; and their effect on thermal conductivity, impregnability, and thermal shock resistance will be evaluated. A survey of potential metal impregnants was conducted. Nickel and nickel/copper alloys appear to have the best combination of physical and thermal properties. Vacuum impregnation using salt solutions, fused salts and oxide slurries have been evaluated as processes for fabricating metal/ceramic composites. Results have indicated that the slurry impregnation technique is the most attractive process. Composites of various metal/ceramic combinations have been successfully fabricated with uniform metal coatings throughout the ceramic body. Nickel, nickel/copper and copper impregnated alumina and zirconia foams have been prepared by the slurry impregnation process and were tested for the thermal switch effect. All composites tested showed good balling of the metal when heated above the melting temperature of the metal. No wetting of the metal on the ceramic foam surfaces was noted. (auth)

23521 (SCL-DR-69-150) PROPERTIES OF PALARITE THERMAL INSULATION. Weber, T. J. (Sandia Labs., Livermore, Calif.). Apr 1970. Contract AT(29-1)-789. 26p. Dep. CFSTI.

Palarite, a low-density, low thermal conductivity material developed for good machinability, is described and characterized. The data are presented as a guide to preliminary engineering. (auth)

23522 (UCRL-Trans-10448) INVESTIGATION ON HIGH-MELTING SYSTEMS. COMPOSITION OF THE TERNARY SYSTEM U-Zr-B, AND MEASUREMENT OF THE COEFFICIENTS OF THERMAL EXPANSION OF $Mo_3(Al,Si)$, MoAlSi, $Mo(Al,Si)_2$, AND TaB_2. Holleck, H.; Benesovsky, F.; Laube, E.; Nowotny, H. Translated by Z. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Monatsh. Chem.; 93: 1075-8 (1962). 6p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 17: 12695.

23523 COMPRESSIVE FRACTURE PHENOMENA OF WC-Co CEMENTED CARBIDE. Hara, Akio; Ikeda, Tadashi (Sumitomo Electric Industries, Ltd., Itami, Japan). J. Jap. Inst. Metals; 34: 120-5(Jan 1970). (In Japanese).

Deformation and fracture mechanism by compression of WC–Co cemented carbide was studied by measuring and observing stress-strain curves, microstructure, and physical properties. It was found that micro-fracture in the alloy structure occurred far in advance of the specimen's fracture. Stress-strain curves deviated from the empirical $\sigma = A\epsilon^n$ law by $\epsilon = 0.2\%$, and a maximum stress was attained at about $\epsilon = 1\%$ or more, further, the stress decreased with an increase of strain until fracture. With microstructure changes, density, hardness, coercive force, and Poisson's ratio were changed. Phase transformation of the cobalt phase was detected. The specimen's fracture was caused by boundary-fracture of the WC phase irrespective of grain size and cobalt content in the alloy. (auth)

23524 PLATINUM AND THE REFRACTORY OXIDES. I. COMPATIBILITY AND DECOMPOSITION PROCESSES AT HIGH TEMPERATURES. Darling, A. S.; Selman, G. L.; Rushforth, R. (Johnson Matthey and Co., Ltd., London). Platinum Metals Rev.; 14: 54-60(Apr 1970).

Under normal atmospheric conditions platinum is exceedingly inert with respect to the more refractory oxides. Severe reactions can occur, however, when the oxidizing potential of the surrounding atmosphere is reduced below a critical level. Alumina, zirconia, and thoria dissociate, oxygen is evolved, and platinum extracts the metal from the refractory to form dilute alloys and low melting point phases. Magnesia is very resistant to this type of decomposition, and appears to be an excellent refractory for use in contact with platinum. The reactions of platinum and alumina, zirconia, magnesia, and thoria at temperatures up to 1700°C are described. (auth) (UK)

Structure and Phase Studies

23525 NEW CHI PHASE IN THE COBALT–CHROMIUM–TUNGSTEN–CARBON SYSTEM. Ettmayer, P.; Seifahrt, H. Monatsh. Chem.; 100: 616-23(1969). (In German).

A compound $Co_{25}Cr_{25}W_6C_2$ was prepared which consists almost entirely of a single χ-phase, with a small amount of μ-phase, $(Co, Cr)_7W_6$ and α-Co solid solution. Alloys were prepared by melting together weighed proportions of the constituent elements

and WC. The new compound was investigated by metallographic x-ray power diffraction, and other methods. It had an α-manganese structure. (Metals Abstr.)

23526 HIGH PRESSURE PHASE DIAGRAM OF ZrO_2. Bocquillon, G.; Susse, C. (CNRS, Meudon, France). Rev. Int. Hautes Temp. Refract.; 6: 263-6(Oct-Dec 1969). (In French).

High pressure investigation in the ZrO_2 phase diagram was made by the method of quenching under pressure. The orthorhombic high temperature form of ZrO_2 in these conditions was shown and its stability studied in the P, T, plane. The existence of a triple point between the cubic, tetragonal, and orthorhombic forms was determined. The phase diagram for ZrO_2 is quite similar to the HfO_2 one, as it could be foreseen from the great analogy between those two oxides. (auth)

23527 SECTORIAL GROWTH OF CUBIC CRYSTALS OF BORON NITRIDE. Filonenko, N. E.; Nikitina, T. P.; Kamentseva, N. M. Dokl. Akad. Nauk SSSR, 187: 569-70(July 21, 1969). (In Russian).

Tabular crystals of cubic boron nitride 0.1 to 0.14 mm in thickness were synthesized under conditions where a saturated gas phase of a melt was obtained in a reaction chamber having a high temperature and pressure. Under examination in a stereoscopic microscope with transmitted and reflected light, all crystals had a tetrahedral structure with a 3 m false symmetry. These crystals differed from earlier crystals of cubic boron nitride by the presence of a perfected facet. The crystals were colored orange, and in most cases had a sector structure. In order to develop the details of the sector growth the crystals were etched with molten KOH at 380°C for periods of 15, 30, and 45 minutes, and then were re-examined under the microscope. The sector growth of the crystals could be clearly followed from the different coloring of growth pyramids of the tetrahedral facets of different signs, from the different rate of growth of various tetrahedra, and from the different distribution of impurities and defects in surface ridge growths of various tetrahedra. Thus this artificial mineral of cubic boron nitride illustrates well the main aspects of sector growth of structure elements (facets, ridges, and peaks), of actual mineral crystals. (TTT)

23528 STRUCTURE OF OXIDE FILMS FORMED ON TANTALUM IN DEAERATED–AERATED HIGH–TEMPERATURE WATER. Nakayama, Tadayuki (Waseda Univ., Tokyo); Osaka, Toshiaki. J. Jap. Inst. Metals; 34: 83-7(Jan 1970). (In Japanese).

Ta samples were heated in an 18-8 stainless steel autoclave filled with deionized water. After heating, the oxide films were identified by means of transmission electron diffraction using an accelerating potential of 100 kV, and then component elements in the thin films were detected by using electron probe microanalyzer. The electron diffractogram of the film formed on Ta in deaerated high-temperature water by oxidation at 300°C for 1 or 24 hr indicated apparently the presence of only the rutile crystal structure. In addition, $FeK\alpha$ and $TaL\alpha$ characteristic x-ray spectra showed the presence of Fe and Ta in the film, indicating that the film was composed of $(Fe,Ta)O_2$. On the other hand, the oxide film produced on the Ta surface in aerated high-temperature water by oxidation at 300°C for 1 hr gave a diffraction pattern corresponding to a hexagonal type structure. The unit cell dimensions for the above oxide were calculated from the reflections (220), (204), and (224); $a_0 = 5.87$ Å, $c_0 = 4.62$ Å, $c_0/a_0 = 0.79$. Further, after heating for 24 hr, the electron diffractogram of the film indicated the presence of the hexagonal crystal structure and the rutile crystal. $CrK\alpha$ and $TaL\alpha$ were detected in the film, and ca 0.67 mg/100 ml Cr^{6+} ions were detected from the water in an autoclave after oxidation. Therefore it was presumed that the Cr ions were dissolved from the autoclave and contributed to the formation of the hexagonal type oxide. (auth)

23529 ON THE VALIDITY OF VEGARD'S LAW FOR UC–UN SOLID SOLUTION. Kai, Hiroshi; Katsura, Masahiro; Sano, Tadao (Osaka Univ.). Nippon Genshiryoku Gakkaishi; 12: 116-23 (1970). (In Japanese).

The validity of Vegard's law for UC–UN solid solutions is still in dispute. A discussion is given on the possible causes of this disagreement among published papers on this subject. The factors taken up include oxygen contamination, errors of chemical analysis in determining the composition of solid solution, slower than expected reaction rate, nonstoichiometry of solid solution, coexisting second phase, and the state of distribution of carbon and nitrogen atoms in the UC–UN lattice. Experiments were performed in vacuo and in nitrogen gas in order to obtain the relation between the lattice parameter and the composition of solid solution, and to determine the effects brought upon this relation by the factors cited above. The lattice parameters of UC–UN solid solution obtained by vacuum sintering at 1,700 and 1,800°C showed a positive deviation from Vegard's law. The same parameters when the solid solution coexisted with UC_2 deviated similarly from Vegard's law. The presence of oxygen in the UC–UN solid solution caused little change of lattice parameters in the vicinity of a composition of $UC_{0.5}N_{0.5}$. (auth)

23530 PHASE TRANSFORMATIONS IN ANODIC OXIDE FILMS. Brandon, D. G.; Zahavi, J.; Aladjem, A.; Yahalom, J. (Technion-Israel Inst. of Tech., Haifa). J. Vac. Sci. Technol., 6: 783-7(July-Aug. 1969).

From International Conference on Thin Films, Boston, Mass. See CONF-690435.

Studies were made of phase transformations induced by electron-beam heating of amorphous anodic oxide films under the electron microscope. Results are summarized for oxide films formed anodically on Al, Ti, Zr, Nb, Ta, and W. (D.L.C.)

23531 THEORY AND TECHNOLOGY OF PRODUCING MATERIALS FOR INSTRUMENT ELECTRODES BY ELECTRON SPUTTERING. 4. INVESTIGATION OF STRUCTURAL AND PHASE COMPONENTS OF MATERIALS FOR INSTRUMENT ELECTRODES. Samsonov, G. V.; Mukha, I. M.; Globa, L. V. Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 71-5(Jan 1970). (In Russian).

The structure of hard alloys of the BK-type containing copper, nickel, and boron nitride alloys was investigated. (auth)

23532 STUDY OF X-RAY AND PICNOMETRIC DENSITY OF INTERSTITIAL PHASES OF ZIRCONIUM COMPOUNDS. Shevchenko, A. S.; Andrievskii, R. A.; Kalinin, V. P.; Lyutikov, R. A. Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 89-91(Jan 1970). (In Russian).

X-ray analysis and picknometric density determination were conducted on the nitrides, carbides, hydrides, carbo-, and nitrohydrides of zirconium. On the basis of the results, conclusions are made on the defect content of metal and non-metal sublattices in these compounds. Defect content of nitride with low (0.05%) oxygen content, of carbides, hydrides, carbo-, and nitrohydrides was dependent only on the incomplementness of the metalloid sublattice. Zirconium nitrides with high oxygen content contain the defects of the metallic sublattice. (auth)

Radiation Effects

Refer also to abstracts 24834, 24835, and 24836.

23533 (BNWL–1279, pp 3.1-31) IRRADIATION BEHAVIOR OF FAST REACTOR FUEL MATERIALS. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Research and development progress is reported on in-pile thermal performance of PuO_2-UO_2 fuels, fuel swelling tests and models, and radiation effects on hypostoichiometric UO_2-PuO_2 fuels. (J.R.D.)

23534 (BNWL–1279, pp 5.1-27) FAST REACTOR DOSIMETRY AND DAMAGE ANALYSIS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Efforts devoted to development of a reference cross section library are summarized along with results of EBR-II dosimetry experiments. Establishment of a fast reactor materials dosimetry center is reported. Results of investigations of radiation damage in reactor materials by computer simulation are presented along with results of irradiation process simulation, and neutron damage function data correlations for reactor materials. Investigation results on strain fields in iron caused by interstitial clusters are presented. The feasibility of using the neutron cavity of PCTR for cross section evaluation is discussed. (J.R.D.)

23535 (BNWL–1279, pp 6.1-4) FAST REACTOR ABSORBER MATERIALS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Results of investigations are reported concerning radiation effects on tantalum encapsulated boron carbide. Radiation testing was conducted using fast and thermal fluxes. Data are included on ^{10}B burnup and B_4C density. (J.R.D.)

23536 (BNWL–1279, pp 7.1-7) NUCLEAR GRAPHITE. Tingey, G. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Efforts to determine the effects of temperature and crystallite size on radioinduced dimensional changes in carbons and graphites are summarized. Results of computer calculations of graphite oxidation in HTGR are also included. (J.R.D.)

23537 (EURFNR–707) IRRADIATION RESULTS OF MIXED UO_2–PuO_2 OXIDE TEST PIECES FOR FAST NEUTRON REACTOR FUEL ELEMENTS. Mikailoff, Hubert; Mustelier, Jean-Pierre;

Bloch, Jacqueline; Conte, Madeleine; Hayet, Lucien; Lauthier, Jean-Claude; Leclere, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translation of report CEA-R-3878. 63p. Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

This report was abstracted from the original language and appears in NSA as 24: 4855.

23538 (GA-9968) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending February 14, 1970. Engle, G. B.; Bokros, J. C.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). 26 Feb 1970. Contract AT(04-3)-167. 18p. Dep. CFSTI.

Needle-coke graphites expanded up to 50 vol % when irradiated to 1.5×10^{22} n/sq cm at 1175 to 1280°C, whereas expansion of near-isotropic materials ranged up to 20%. Irradiation of a number of graphite specimens at 1000°C to 3×10^{21} n/sq cm followed by irradiation at 760 to 800°C to 5×10^{21} n/sq cm showed no reduction in the rate of dimensional change over other specimens irradiated to 5×10^{21} n/sq cm at 1000°C. Thermal expansivities of near-isotropic graphites were reduced, whereas those of needle cokes either remained unchanged or increased during irradiation. The changes were correlated with structural features of the materials. Large pores were observed micrographically in the graphites that expanded at high fluences. Samples of hot-worked graphite and massive pyrolytic carbon (as-deposited and annealed) were measured after an additional irradiation period in capsule GE-H-13-17. Maximum exposures were 1.4×10^{22} n/sq cm at 1225 to 1300°C and 2×10^{21} n/sq cm at 750 to 800°C. Changes in dimensions, thermal expansivity, and x-ray diffraction parameters were measured. Dimensional changes of graphite specimens irradiated in Dragon at 975 to 1240°C to 0.9 to 2.4×10^{21} n/sq cm compared favorably with data from the ETR experiments. (auth)

23539 (GEMP-741) REFRACTORY METAL FUEL ELEMENT RESEARCH. Final Report. Collins, J. F. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Dec 1969. Contract AT(40-1)-2847. 15p. Dep. CFSTI.

Isothermal stability testing of refractory metal clad W-UO_2 cermet fuel element specimens for times in excess of 10,000 hours was completed. Optimum thermal stability and fuels compatibility was shown by W-Re and W-Re-Mo clad W-UO_2 systems at all temperatures to 1800°C in helium. The last of a series of in-pile tests of eight W-Re-Mo clad W-UO_2 fuel specimens was completed in the ORR with the achievement of leak-free operation for 3400 hours at 1650°C to a burnup of 1.6×10^{20} fissions/cm^3 without loss of fission products. This improved performance was attributed to end-plenums for storage of fission gases and to the use of lower density cermet fuel cores. (auth)

23540 (JAPFNR-6) PLUTONIUM FUEL DEVELOPMENT SEMIANNUAL REPORT. VOLUME V. JULY-DECEMBER 1968. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Translation of Japanese report. 216p. (PNC-N-851-69-9005; PNCPU-40; PNCT-9005). Dep. CFSTI (U. S. Sales Only).

Research and development progress is reported on design of fuel assemblies for in-pile testing, preparation of UO_2-PuO_2 fuels, power distribution for critical experiments with PuO_2-UO_2 lattices, radiation effects on PuO_2-UO_2 fuel specimens, thermal diffusivity of UO_2 and PuO_2-UO_2 fuel specimens, thermal conductivity of Vipac UO_2 fuel , phase studies of Pu-O-U, mechanical properties of fuel pins, fissile material accountability, gamma spectrometric determination of PuO_2, and personnel radiation protection. (J.R.D.)

23541 (ORNL-TM-2635) EXPERIMENT DESCRIPTION AND HAZARDS EVALUATION FOR THE SERIES I ORNL OXIDE FUELS IRRADIATION IN EBR-II. Olsen, A. R. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 78p. Dep. CFSTI.

The Series I fuel tests involve five encapsulated stainless-steel-clad fuel rods containing Sphere-Pac (U,Pu)O_2 derived from the ORNL sol-gel process. The analysis results indicate that these experiments can be conducted at a nominal peak linear heat rate of 14.7 kW/ft to a burnup of 50,000 MWd/Mt of U + Pu. A memorandum covering the details of fabrication is in preparation, and the five rods are being irradiated in a Row 4 position in the reactor. (auth)

23542 ENERGY OF THE DEFECTS INDUCED BY NEUTRON IRRADIATION IN MgO. Roux, Andre (Institut National des Sciences Appliquees, Villeurbanne, France); Elston, Jean. Compt. Rend., Ser. C; 270: 505-8(9 Feb 1970). (In French).

The liberation of Wigner energy stored in the irradiated magnesium oxide at 90°C should lead mainly to the recovery of Frenkel defects of cationic-type. (auth)(France)

Plastics and Other Materials

Refer also to abstracts 22799, 23501, 23519, 24134, 24821, and 24834.

23543 (NVO-38-22) EVALUATION OF "TUF" CONCRETE USED TO REPLACE THE ORIGINAL LINER AT U-19e. Rommel, Robert R.; Craig, William E.; Murphy, Sheldon D.; Fine, Herbert D. (Fenix and Scisson, Inc., Mercury, Nev.). Dec 1969. Contract AT(26-1)-38. 119p. Dep. CFSTI.

In November, 1968, it was found that there was water in the shaft up to 680 feet above the centerline of the cavity of the drill hole U19e. Chemical grout was pumped behind the liner but a seal could not be effected. It was found that an area on the North side of the cylindrical portion of the cavity had pushed inward and caused a structural failure. The CDC liner was removed completely, leaving the outer steel liner intact, and new liner of Tuf (high-strength concrete) was used. A rubber liner was used inside the steel shell in an attempt to provide a better water seal. The replacement procedure is explained and an evaluation was made of the characteristics of the Tuf concrete liner. (J.C.W.)

23544 OPTICAL ACTIVITY OF α-QUARTZ IRRADIATED BY FAST NEUTRONS. Zubov, V. G.; Kadyshevich, E. A.; Osipova, L. P.; Shtyrkova, A. P. (Moscow State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 14: 535-8(Jan-Feb 1970).

Translated from Kristallografiya; 14: 634-8(Jul-Aug 1969).

Data were obtained for the specific rotation of large specimens of α-quartz neutron irradiated at fluxes of 3.0×10^{19}, 3.5×10^{19}, and 6.0×10^{19} n/cm^2, at λ = 405, 436, 546, 578, and 589 mμ. A polarimetry method was used to measure the specific rotation. In order to determine the integral number of half rotations of the electric vector when light was passed through the specimen, the characteristics of the scattered light in irradiated quartz were observed. (auth)

23545 INTERNAL STRESSES AND REFRACTIVE INDEX OF QUARTZ IRRADIATED WITH FAST NEUTRONS. Shtyrkova, A. P. (Moscow State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 14: 624-6(Jan-Feb 1970).

Translated from Kristallografiya; 14: 726-9(Jul-Aug 1969).

Optical effects of internal stresses induced by neutron doses of 3.5 and 6×10^{19} n/cm^2 were studied for large quartz samples with $20 \times 20 \times 50$ and $30 \times 30 \times 30$ mm dimensions. Parallel convergent and diffuse polarized light were used with conoscopes to study the internal stresses. At the center of the samples, the uniaxial pattern did not change, but at the periphery, biaxial patterns were observed, with the angle between the optic axes varying from 10 to 25°. The unilateral stresses are estimated to be ~2 to 4 kg/mm^2. The refractive index was also found to become heterogeneous within a sample after irradiation. The results can be explained as being due to thermal spikes produced by the irradiation, and to the subsequent freezing of the deformed regions. (D.L.C.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

23546 EXPLORATION OF THE UNIVERSE. SECOND EDITION. Abell, George. New York; Holt, Rinehart, and Winston (1969). 733p.

This book is designed for a one- or two-semester course as an introduction to astronomy and astrophysics. No special training in science or mathematics is required for an understanding of the text. The book is liberally illustrated in black and white and some color. (W.D.M.)

Cosmic Ray Exposure Ages

23547 DATING OF METEORITES BY THE HIGH-TEMPERATURE RELEASE OF IODINE-CORRELATED ^{129}Xe. Podosek, F. A. (Univ. of California, Berkeley). Geochim. Cosmochim. Acta; 34: 341-65(Mar 1970).

Correlations between the amounts of ^{129}Xe and ^{128}Xe released in stepwise heating of neutron-irradiated meteorites were used to determine the initial ratio $^{129}I/^{127}I$ and hence a relative formation time for the various samples. The formation times in millions of years (relative to the L4 chondrite Bjurböle) of nine specimens are as follows: -3.9 ± 0.7 for Karoonda (C4 chondrite); 3.1 ± 0.6 and 10.5 ± 0.7 for the matrix and chondrules, respectively, of Chainpur (LL3); 7.5 ± 1.0 for St. Severin (LL6); -3.9 ± 2.9 and -2.3 ± 1.0 for the matrix and chondrules, respectively, of Allegan (H5); 3.6 ± 0.7 for Peña Blanca Spring and 20.8 ± 9.5 for Bishopville (aubrites); 3.8 ± 0.7 for a silicate inclusion of the iron meteorite El Taco (Campo del Cielo). No assumptions were made about the amount of ^{129}Xe in the trapped gas. The correlations for previously published data were also recalculated in the same way, with no assumptions about trapped ^{129}Xe. For a group of chondrites previously reported to be isochronous with a mean simultaneity of 2.5 million years, the recalculation confirms this mean simultaneity, but significant differences in formation times are resolved. An iodine–xenon age of 53 ± 9 million years (after Bjurböle) was obtained from unpublished data for the achondrite Lafayette. The reliability of iodine–xenon ages of individual meteorites is considered; in particular, the ages of Bishopville and Lafayette are less reliable than those of most other meteorites studied, especially in view of the anomalous ages reported. The relevance of iodine–xenon dating to theories of nucleosynthesis, early solar system chronology, and theories of meteorite parent-body formation is discussed. (auth) (UK)

Stars

Refer also to abstracts 23762, 23976, 24435, and 24516.

23548 (NYO-3962-2) ANNUAL PROGRESS REPORT [ON NUCLEAR PHYSICS AND NUCLEOSYNTHESIS]. [Cameron, A. G. W.] (Yeshiva Univ., New York. Belfer Graduate School of Science). [17 Mar 1970]. Contract AT(30-1)-3962. 11p. Dep. CFSTI.

A brief summary is given on the work carried out in the areas of neutron-star matter, neutron-rich nuclei, the URCA process in white dwarfs, and the nuclear mass formula. (W.D.M.)

23549 LIGHT VARIATION OF FOUR MAGNETIC VARIABLE STARS. van Genderen, A. M. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 1: 123-7(Feb 1970).

Photoelectric observations of the magnetic variable stars HD 8441, 21 Per, ι Cas, and HD 25 354 are detailed. The first three stars were observed with a red filter only, the fourth one was also observed in UBV. (auth)

23550 PHOTOELECTRIC OBSERVATIONS OF 32 CYGNI. Johansen, Karen T.; Rudkjoebing, J.; Gyldenkerne, K. (Univ. of Copenhagen Observatory, Brorfelde, Denmark). Astron. Astron. Astrophys., Suppl, Ser.; 1: 149-64(Feb 1970).

The long-period eclipsing binary 32 Cyg was observed at Copenhagen University Observatory in Brorfelde during the 1959, 1962, and 1965 eclipses. The observations were made with UBV standard filters and several narrow-band filters, and the combined light curve is discussed. A comparison is made with results obtained by other observers. At least the 1965 eclipse seems to be total. The atmospheric nature of the eclipse is demonstrated by the fact that at a certain phase outside totality the absorbed fraction of the B-star radiation depends on the spectral region of observation. (auth)

23551 PHOTOELECTRIC OBSERVATIONS OF EARLY A STARS. Johansen, Karen T.; Gyldenkerne, K. (Univ. of Copenhagen Observatory, Brorfelde, Denmark). Astron. Astrophys., Suppl. Ser.; 1: 165-88(Feb 1970).

Photoelectric observations of the β index and of indices similar to those of the Strömgren uvby system were made for 437 field stars and for a number of stars in the Coma Berenices, Praesepe, NGC 6633, and NGC 1662 clusters. Of the field stars, 377 are A0–A2 stars north of declination $-5°$ with $V \leq 6.0$; in the clusters mostly A stars were observed. The night-to-night correction method is described and the transformation of the observed indices to the uvby and β standard systems is discussed in detail. (auth)

23552 CATALOGUE OF PROPER MOTIONS FOR 437 A STARS. Olsen, H. J. Fogh (Univ. of Copenhagen Observatory, Brorfelde, Denmark). Astron. Astrophys., Suppl. Ser.; 1: 189-97(Feb 1970).

Proper motions and radial velocities are given for 437 A stars observed photoelectrically by Johansen and Gyldenkerne. Most of the proper motions are improved GC motions transformed to the FK4 system. (auth)

23553 NARROW-BAND PHOTOMETRY OF LATE-TYPE STARS. Haeggkvist, L.; Oja, T. (Uppsala Astronomical Observatory). Astron. Astrophys., Suppl. Ser.; 1: 199-232(Feb 1970).

The distribution of stars in the direction perpendicular to the galactic plane is investigated. It is limited to late-type stars, which are studied by means of interference filters; the break at the G band and the cyanogen absorption are measured. The catalog includes all late-type stars brighter than $V = 5$ north of declination $-10°$ and those brighter than $V = 6$ north of galactic latitude $+60°$. The relation between the two-dimensional classification established for the G and K stars and the MK classification is studied. It is shown that the giants and the dwarfs are well separated from each other and that the separation can be made complete if the criteria are complemented by the B–V color. It is also found that the M giants can be classified quite accurately by means of the same criteria. The connection between the spectrophotometric criteria and the intrinsic colors in the UBV system is investigated, and it is found that different relations hold for the dwarfs and the giants. The mean errors of typical B–V color excesses derived from the criteria and B–V are about ± 0.02 for the dwarfs and ± 0.03 to ± 0.05 for the giants. The absolute magnitudes of the late-type giants are discussed and a relation between the mean absolute magnitude in a volume of space and the spectrophotometric criteria is derived from astrometric data only (trigonometric parallaxes and proper motions in combination with radial velocities). The dispersion of the absolute magnitudes is about ± 0.6. (auth)

23554 CASE B OF MASS EXCHANGE IN SYSTEMS $4 + 3.2M_\odot$ AND $4 + 1.6M_\odot$. Harmanec, Petr (Astronomical Inst., Ondrejov, Czech.). Astrophys. Space Sci.; 6: 497-503(Mar 1970).

Two examples of case B of mass exchange are computed to estimate the effect of basic initial parameters on the course and the results of mass exchange. It seems that the resulting mass of the original primary is independent of the initial mass ratio, the resulting orbital period is independent of initial mass of the primary, and surface hydrogen content is independent of both of these parameters. (auth)

23555 ONE EXAMPLE OF MASS EXCHANGE IN CASE AB IN SYSTEM $5M_\odot + 4M_\odot$. Horn, J. (Astronomical Inst., Ondrejov, Czech.). Astrophys. Space Sci.; 6: 492-6(Mar 1970).

Evolution of a binary system with masses of $5M_\odot$ and $4M_\odot$, respectively, and with orbital period of 1.41 days is studied by means of nonstationary model calculations under assumptions of conservation of total mass and total orbital angular momentum of the system. As a result of mass exchange between the components a binary with masses of 8.46 and 0.54 $M_\odot$ is obtained. Physical parameters of the final product indicate possible connection with shell stars. It is also pointed out that the new secondary component can become rotationally unstable soon after the end of mass exchange. (auth)

23556 DEVELOPMENT OF A COCOON STAR. Davidson, Kris (Cornell Univ., Ithaca, N. Y.). Astrophys. Space Sci.; 6: 422-35(Mar 1970).

A newly formed massive star is likely to be surrounded by dense gas and dust as it approaches the main sequence. Radiation pressure must push some of the inner material outward before

the star begins to produce ionizing radiation; this affects the formation of the H II region. A remarkably dense "dust front" may precede the ionization front. The observable radio and infrared spectra are discussed. If the dust cloud is composed of small graphite grains, extraordinarily large far-infrared fluxes are possible. (auth)

23557 STATISTICAL STUDY OF BINARY STARS. Heintz, Wulff D. (Swarthmore Coll., Pa.). J. Roy. Astron. Soc. Can.; 63: 275-98(Dec 1969).

There have been many papers investigating correlations among double star parameters, and it was thought worthwhile to reconsider some of these issues in view of the improved material now available. For the theory of star formation, the total frequency of binaries and the distribution of orbital axes are important data. In attempting to determine these, the author aims at the same purpose as the earlier investigation of Kuiper (1935) but partly along different lines. (W.D.M.)

23558 LECTURES ON VARIABLE STARS. Christy, R. F. (California Inst. of Tech., Pasadena). J. Roy. Astron. Soc. Can.; 63: 299-307(Dec 1969).

In Chapter I an extensive review of the linear theory of pulsation is not given, since this subject has been dealt with in detail by a number of authors. A synopsis of some aspects of the problem is given which is helpful in understanding some of the later discussion. Chapter II consists of a discussion of the nonlinear method. The discussion is intended to clarify some aspects of the problem and to introduce material for discussion in Chapters III and IV. (W.D.M.)

23559 PHOTOELECTRIC OBSERVATIONS OF 31 CYGNI. Gyldenkerne, K.; Johansen, Karen T. (Univ. of Copenhagen Observatory, Brorfelde, Denmark). Astron. Astrophys., Suppl. Ser.; 1: 129-48(Feb 1970).

The long-period eclipsing binary 31 Cyg was observed at Copenhagen University Observatory in Brorfelde during the 1962 eclipse and in 1965. The observations were made with UBV standard filters and several narrow-band filters. A comparison was made with results obtained by other observers. The atmospheric nature of the eclipse is demonstrated by the fact that the fraction of the light of the B-type secondary obscured at a certain phase outside totality depends on the spectral region of observation. The epoch of mid-eclipse is J. D. 2 437 685.65 and the period equals 3784 days. (auth)

23560 PERTURBATION THEORY FOR STELLAR INTERIOR PROBLEMS. Edwards, Terry W. (Univ. of Missouri, Columbia). Astrophys. Space Sci.; 6: 436-49(Mar 1970).

A rather general first-order linearized perturbation theory is derived with which one can calculate a quasi-static equilibrium stellar interior model if given an initial approximation thereto. The process developed is applicable to both static and evolutionary models, wherein slightly different physical assumptions (e.g., gas characteristics) or physical conditions (e.g., matter composition) are imposed. The correction to the given model is obtained through bi-directional quadrature with fitting at an intermediate position; however, no trial integrations are necessary. (auth)

23561 MAXIMAL MASSES OF ^{56}Fe AND ^{56}Ni STARS. Kovetz, A.; Shaviv, G. (Tel Aviv Univ., Israel). Astrophys. Space Sci.; 6: 396-9(Mar 1970).

Upper bounds are derived for the masses of pure ^{56}Ni and ^{56}Fe stars, which are dynamically stable with respect to photodisintegration. Possible effects on stellar evolution are discussed. (auth)

23562 POLYTROPIC MODEL FOR THE HELIUM SHELL FLASH. Thomas, Hans-Christoph (California Inst. of Tech., Pasadena). Astrophys. Space Sci.; 6: 400-14(Mar 1970).

A model consisting of two polytropes is constructed, to represent a helium core of a star during the helium-shell flash occurring at the onset of helium burning in a degenerate core. The maximum temperature reached during the flash can be predicted as a function of core mass and mass inside the helium-buring shell. This temperature will generally be too low for the production of neutrons out of ^{14}N. Some additional results on the helium shell flash in a star of 1.3 $M_\odot$ are also presented. (auth)

23563 APPLICATIONS OF THE RITZ METHOD TO NON-STANDARD EIGENVALUE PROBLEMS. Andrew, A. L. (La Trobe Univ., Melbourne). J. Aust. Math, Soc.; 10: 367-84 ([Sep 1969)].

The possibility of application of the Ritz method to eigenvalue problems where the linear operators are not necessarily positive definite and a minimum (or maximum) eigenvalue may not exist, such as with nonradial oscillations of stars, is considered. Cases exist which aren't covered by classical theory, to which the Ritz method may be applied for useful results. (auth)

23564 THE RAYLEIGH SCATTERING CROSS SECTIONS OF He, C, N, AND O. Tarafdar, S. P.; Vardya, M. S. Mon. Notic. Roy. Astron. Soc.; 145: 171-80(1969).

Rayleigh scattering cross sections of He, C, N, and O were computed by the quantum defect method. Fairly good agreement was obtained between the results of dipole length and dipole velocity formalisms. The wavelength-independent part of the polarizabilities obtained in the calculation was compared with the static polarizabilities given by others. At large wavelengths the Rayleigh scattering cross sections of He, C, N, and O relative to H, were found to be approximately in the ratio of 0.1 : 7.9 : 4.1 : 1.4. The effect of wavelength-dependent polarizabilities on Rayleigh scattering cross sections was also investigated. The importance of Rayleigh scattering vis-a-vis pure absorption is discussed. (auth) (UK)

23565 PHOTOMETRIC AND SPECTROPHOTOMETRIC VARIATIONS OF THE Hβ LINE OF THE STAR HD 109387 (χ Dra.) DURING THE NIGHT OF JANUARY 23 AND 24, 1969. Adam, Gilles (Observatoire, Lyon); Bigay, Joseph-Henri; Delplace, Anne-Marie; Duval, Michel; Garnier, Robert; Herman, Renee; Peton, Alain Compt. Rend., Ser. B; 269: 1332-4(22 Dec 1969). (In French).

Photometric and spectrophotometric variations of the Hβ line of the star HD 109387 (χ Dra.) during the night of January 23 and 24, 1969. Certain variations in intensity of the line Hβ of the star χ Dra are shown by photoelectric photometry; these variations seem to be in close correlation with the spectral variations of the Hβ line observed simultaneously. (tr-auth)

23566 INFRARED PHOTOMETRY OF A HEAVILY REDDENED CLUSTER IN ARA. Borgman, J.; Koornneef, J.; Slingerland, J. (Kapteyn Observatory, Roden, Netherlands). Astron. Astrophys.; 4: 248-52(Feb 1970).

Westerlund's (1968) identification of an extended infrared object found by Price (1968) is confirmed. At least twelve objects brighter than K = 5.0 m are found in the cluster area, nine of which can be positively identified as supergiants in an extremely reddened cluster; the visual absorption is at least 12.8 m. (auth)

23567 MILNE'S PROBLEM IN THE THEORY OF SPECTRAL LINE FORMATION. Ivanov, V. V. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 1-3(Spring 1968).

Translated from Astrofizika; 4: 5-13(1968).

Milne's problem is discussed in the case of scattering with complete frequency redistribution. The asymptotic behavior of the corresponding source function in deep layers is investigated. (auth)

23568 INTERPRETATION OF THE SPECTRUM OF CLASSICAL CEPHEIDS. Golin'ko, V. I. (Odessa State Univ., USSR). Astrophysics (Engl. Transl.); 4: 4-10(Spring 1968).

Translated from Astrofizika; 4: 15-30(1968).

Emission of radiation by an optically thick hydrogen envelope is analyzed. It is shown that the emission time is considerably shorter than the time necessary for a shock wave moving from the He III zone to reach the surface. The solution obtained for the hydrogen envelope is used to estimate the thickness of the hot layer moving behind the shock-wave front. Emission by the shock front is used to explain the main features of the H and K emission lines of Ca II. The emission-line profiles for these lines are constructed with allowance for absorption in the upper layers. (auth)

23569 INVESTIGATION OF THE DYNAMICS OF TRIPLE SYSTEMS BY THE METHOD OF STATISTICAL TESTS. II. Agekyan, T. A.; Anosova, Zh. P. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 11-16(Spring 1968).

Translated from Astrofizika; 4: 31-40(1968).

The equations of motion for a triple system were integrated numerically on a computer for 100 random initial configurations. The components of the system were assumed to be at rest at the initial time. The equations were linearized in the case of close binary approaches of the components. In all the systems the motions terminated in decay. In each case the decay was a consequence of a close triple approach of the components. The mean decay time $\overline{T}$ was found to be 110.1 τ, where τ is the mean time of the component motion through the system. The rms deviation σ of the decay time from the mean is 125.0 τ. By linearizing the equations of motion the gap in the calculations reported by Agekyan and Anosova (1967) for 38 initial conditions with small velocity of the components at the initial time was filled. For these cases, the calculations were carried out up to the decay stage. From the data reported here and the data from Agekyan and Anosova (1967), it was found that $\overline{T}$ = 80.7 τ and σ = 83.0 τ for 100 systems with random initial configurations and small initial velocities of the components. For a set of 200 triple systems with random initial conditions it was found that $\overline{T} = (95.4 \pm 6.9)\tau$. (auth)

23570 ORIENTATION IN SPACE OF PLANETARY NEBULAE. Grinin, V. P.; Zvereva, A. M. (Crimean Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 43-4(Spring 1968). Translated from Astrofizika; 4: 135-9(1968).

The results of a study of the orientation in space of 128 planetary nebulae are used to investigate the effect of the magnetic field of the Galaxy on their expansion. (auth)

23571 NONSTATIONARY DIFFUSION OF RADIATION IN A GAS. Terebizh, V. Yu. (Byurakan Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 45-6(Spring 1968). Translated from Astrofizika; 4: 141-4(1968).

The solution of a number of astrophysical problems involves the determination of the parameters of a nonstationary radiation field in a medium. Methods that enable one to establish exact solutions for certain problems were developed previously. These solutions have a very complicated form even in the simplest cases, for example, in the case of one-dimensional homogeneous media. There is, therefore, considerable interest in the structure of the solutions under the most general assumptions. In this note such problems are considered. (W.D.M.)

23572 A NEW VARIABLE OF THE U GEMINORUM TYPE. Markaryan, B. E. (Byurakan Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 46-7(Spring 1968). Translated from Astrofizika; 4: 144-5(1968).

Analysis of photographs obtained with an objective prism mounted on the 40-inch Schmidt telescope resulted in the discovery of a flare variable with the following coordinates: α_{1950} = 8h 49.9m, S_{1950} = 58°. The position of the star is indicated on accompanying photographs. The photographs were obtained both at light maximum and minimum. (W.D.M.)

23573 BINARY NATURE OF HD 191 566. Vitrichenko, E. A.; Polkanov, Yu. A.; Shutov, Yu. I. (Crimean Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 47-9 (Spring 1968). Translated from Astrofizika; 4: 146-50(1968).

Evidence is given in favor of the hypothesis that the system HD 191566 + HD 191567 is a physical binary. A table of the parameters of both stars is given. (W.D.M.)

23574 THEORETICAL INTERPRETATION OF FLARE PHENOMENA IN NONSTABLE STARS. Gurzadyan, G. A. (Byurakan Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 52(Spring 1968). Translated from Astrofizika; 4: 154-6(1968).

The theory developed on the basis of the fast-electron hypothesis provides a satisfactory explanation of a broad range of observed effects, covering various aspects of flare phenomena in dwarfs belonging to late spectral types. Verification of this hypothesis by observations in the far-infrared and ultraviolet is discussed. (W.D.M.)

23575 PLANETARY NEBULAE. XI. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc.; 39: 220-3 (Apr 1970).

The discovery and early work on planetary nebulae are very briefly summarized, and emission mechanisms are discussed. The derivation and significance of the central-star temperatures are considered in some detail. (W.D.M.)

23576 MODELS FOR NEUTRON-CORE STARS BASED ON REALISTIC NUCLEAR-MATTER CALCULATIONS. Wang, C. G.; Rose, W. K.; Schlenker, S. L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 160: L17-20(Apr 1970).

A realistic nuclear-matter calculation has shown that, at densities below 10^{15} g cm^{-3}, the stable mass range for neutron-core stars is between 0.13 and 0.26 $M_\odot$. At densities greater than 10^{15} g cm^{-3}, hyperons become important; and an accurate equation of state for hyperons is beyond the knowledge of present-day physics. (auth)

23577 NEAR-INFRARED PHOTOMETRY OF TWO EXTREMELY RED OBJECTS. Lockwood, G. W. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 160: L47-50(Apr 1970).

The infrared objects IRC + 10216 and IRC + 40004 (CIT 1) were observed on a five-color narrow-band photometric system capable of detecting near-infrared TiO and VO features in M-type stars. IRC + 40004 appears to be about M9 on this system, but IRC + 10216 is featureless. (auth)

23578 IDENTIFICATION OF NOVA SERPENTIS 1970. Burkhead, Martin S.; Seeds, Michael A. (Indiana Univ., Bloomington). Astrophys. J.; 160: L51(Apr 1970).

Nova Serpentis was identified as a prenova star of m_v = 16.1 and (B−V) + 0.8. (auth)

23579 CONVECTION IN ENVELOPES OF WHITE DWARFS. Van Horn, H. M. (Univ. of Rochester, N. Y.). Astrophys. J.; 160: L53-6(Apr 1970).

Incomplete ionization in the envelopes of white dwarfs leads to extensive surface convection zones which may modify the spectra and drastically reduce the lifetimes of these stars. (auth)

23580 A JETLIKE STRUCTURE ASSOCIATED WITH THE CRAB NEBULA. van den Bergh, Sidney (Univ. of Toronto). Astrophys. J.; 160: L27(Apr 1970).

A faint jetlike structure was found outside the main body of the Crab Nebula. (auth)

23581 NONPERIODIC PHENOMENA IN VARIABLE STARS. International Astronomical Union, Commissions 27 and 42, IVth Colloquium on Variable Stars, Held in Budapest, Hungary, 5–9 September 1968. Detre, L. (ed.). Dordrecht, Holland; D. Reidel Publishing Company (1969). 500p. Dfl. 95.-. (CONF-680973).

Sixty-seven papers were presented on theory of supernovae, stages of early stellar evolution (Herbig–Haro objects, T Tauri stars, flare stars, etc.), problems of shell stars, magnetic variables, irregular activities in Cepheids, and late-type giants. Many papers deal with eruptive binaries and symbiotic stars, contact and conventional binaries, etc. (W.D.M.)

23582 SUPERNOVAE AND THEIR REMNANTS. Proceedings of the Conference on Supernovae, Held at Breenbelt, Maryland, November 2–3, 1967. Brancazio, Peter J.; Cameron, A. G. W. (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1969). 246p. $17.50. (CONF-671147).

This book consists of thirteen papers presented at a conference on supernovae held at the Goddard Institute for Space Studies. Of particular interest were the many problems involved in relating the observational data on supernovae to theoretical calculations of the dynamics of these explosions. (W.D.M.)

23583 A METHOD FOR THE CONSTRUCTION OF MODEL STELLAR ATMOSPHERES. Napier, W. McD. Mon. Notic. Roy. Astron. Soc.; 147: 287-93(1970).

A noniterative variational technique for constructing model stellar atmospheres is described. There are no restrictions on the physical state of the atmosphere other than hydrostatic equilibrium and energy conservation. The temperature within the atmosphere is expressed as a series in pressure, the coefficients of which are determined by a search technique. The method is rapid and appears to be well suited to the computation of grids of model atmospheres. (auth) (UK)

23584 SUPERGIANTS IN TURMOIL. Pardoe, J. New Sci.; 46: No. 695, 28-9(2 Apr 1970).

VV Cephei are a pair of stars, one very hot and the other cool, of very large dimension and mass (between 35 and 80 $M_\odot$). The hot star is surrounded by a cloud of excited hydrogen gas. The larger of the two stars throws out matter that falls into the smaller star. The whole system lies within a nebula in which the forbidden lines of iron are formed. There are thirteen VV-Cephei-type stars. (UK)

23585 ON THE INFRARED LINE SPECTRA OF PLANETARY NEBULAE. Flower, D. R. (University Coll., London). Mon. Notic. Roy. Astron. Soc.; 147: 245-52(1970).

Results of detailed calculations of the infrared line spectra of NGC 7662, IC 418, and NGC 2392 are presented. The calculated intensity of the [Ne II] 12.79-μ line in IC 418 is found to be in good agreement with observations and estimates of the intensity of this line are given for four other planetary nebulae in which it should be relatively intense. The potential importance of more numerous and extensive observations of the infrared lines, particularly for the determination of ion and electron densities, is discussed. (auth)

23586 THE INTENSITY OF Sc I λ6305 A IN LATE-TYPE STARS. Griffin, R. F. Mon. Notic. Roy. Astron. Soc.; 147: 303-21(1970).

The possibility of using the Cambridge technique of narrow-band spectrometry to make direct measurements of the equivalent widths of stellar absorption lines is discussed. An attempt to measure the resonance line of Sc I at λ6305 Å in some 300 late-type stars has been made. As far as equivalent widths are concerned, the attempt was not successful, partly owing to unexpectedly strong blending by CN lines in the bands observed. An additional difficulty, which exists in all photoelectric spectrometry with narrow bands (including high-resolution scanners), is presented by the tolerance on the accuracy of the exit slits. This tolerance may often be near to that associated with optical surfaces; it was not met in the construction of the diaphragm

used for scandium observations. The Sc I ratios show a rapid variation with spectral type; at a given type, high-luminosity stars show the strongest scandium lines. The relationship between Sc I and (B−V) is almost independent of luminosity class, but there is a real dispersion of individual stars (not explicable as observational error) about the mean relationship. At each individual spectral type for Class III stars, there is a correlation between Sc I and (B−V); it is not clear whether this may be ascribed to errors in classification. Carbon stars appear to have very strong scandium lines. (auth) (UK)

23587 INFLUENCE OF A POLOIDAL MAGNETIC FIELD ON CONVECTION IN STELLAR CORES. Moss, D. L.; Taylor, R. J. (Univ. of Sussex, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 133-8(1970).

It is shown that a strong poloidal magnetic field can suppress convection in a star with a small convective core but that a strong enough field to suppress convection must be largely confined within the star. This in turn means that no presently observed surface magnetic field extended through the interior of a star is by itself strong enough to suppress core convection. If convection is suppressed by a magnetic field which does not seriously distort the spherical symmetry of a star, the surface properties of the star are essentially unaffected. (auth)

23588 ROTATION AND THE DC WHITE DWARFS. Wickramasinghe, D. T.; Strittmatter, P. A. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 123-32(1970).

The effect of uniform rotation on spectra of white dwarfs is investigated to ascertain whether the apparently lineless DC stars may be accounted for in terms of extreme Doppler broadening but otherwise normal abundances and opacity sources. It is shown that, under these conditions, the hydrogen Balmer lines should be easily detectable even at maximum rotational velocity. The general absence of absorption lines of other elements in DA white-dwarf spectra may, however, be understood in terms of even moderate rotation. The likely effects of differential rotation and extreme hydrogen deficiency are briefly discussed and the latter, combined with rotation is suggested to be the most likely explanation of the DC white dwarfs. (auth)

23589 EXPANDING ATMOSPHERES IN OB SUPERGIANTS. IV. A MASS-LOSS SURVEY. Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, B. C.). Mon. Notic. Roy. Astron. Soc.; 147: 161-76(1970).

A study of medium-dispersion spectra of seven very bright early-type stars has indicated the presence, to a varying degree, of expansion in the outer layers of their envelopes. A brief survey of other early-type supergiants has indicated that a similar situation arises in eleven of them. Combined with the results of detailed studies of four stars with large mass loss, these conclusions indicate that mass loss is common among the brightest hot stars. The rate of mass loss increases with luminosity and effective temperature amongst the OB stars and may well be an important consideration in the evolution of massive stars. (auth) (UK)

23590 ORIGIN OF THE ULTRA-SHORT-PERIOD BINARY WZ SAGITTAE. Vila, S. C. (Univ. of Pennsylvania, Philadelphia). Nature (London); 225: 1229-30(28 Mar 1970).

The recent discovery of several binaries with periods of a few hours has raised the problem of their past evolution. Amongst these binaries is WZ Sge, which is thought to consist of a DA white dwarf of estimated mass $M = 0.59\ M_\odot$ and a secondary of mass $m = 0.03\ M_\odot$. The radii are, respectively, $R \simeq 0.87 \times 10^8$ cm and $+ \simeq 7 \times 10^9$ cm, and the separation $a = 3.7 \times 10^{10}$ cm. If it is assumed that the secondary is a completely degenerate star and the mass-radius relationship calculated for such stars by Zapolsky and Salpeter (Astrophys. J. 158: 809(1969)) is applied it is inferred that the star is composed of almost pure hydrogen, and this indicates that in its past the star has never been massive enough to burn hydrogen. The primary white dwarf is assumed to be the remnant of a more massive star which once burned hydrogen and became a red giant with radius > 100 $R_\odot$. Among matters discussed are the initial separation of the two stars, accretion, movements under gravitational attraction, changes in radii, and period. It is concluded that the secondary was, almost at all times, outside the envelope of the primary. One way for accounting for the present position of the secondary is to suppose that the giant primary ejected matter with very low velocity until only the present mass remained, and that part of this matter was accreted by the secondary, with decrease of mutual separation, but with the secondary always outside the envelope of the primary. Changes in mass and separation are discussed on this hypothesis. The initial secondary mass is found to be $m_0 = 0.87 \times 10^{33}$g. The values for initial separation and mass are comparable to those for Jupiter and the Sun. If the Sun became a giant star and lost a considerable fraction of its mass at very low flow velocity, part would be collected on Jupiter, which would then move close to the Sun, and their final configuration would probably not be very different from that for SW Sge. (UK)

23591 OBSERVATIONS OF Ap AND Am STARS. Floquet, M. (Observatoire, Meudon, France). Astron. Astrophys., Suppl. Ser.; 1: 1-5(Jan 1970). (In French).

The spectrograms of 27 A stars with unique spectra and metallic lines and three possible Am stars were studied and are described. This permitted classification to be given or confirmed a classification already existing. (tr-auth)

23592 SPECTRAL CLASSIFICATION OF 112 A AND F STARS, 89 OF WHICH WERE Am STARS. Bertaud, Ch. (Observatoire, Meudon, France). Astron. Astrophys., Suppl. Ser.; 1: 7-13(Jan 1970). (In French).

The spectra of 112 stars were obtained at the Haute-Provence Observatory in February and September, 1968, with a telescope having an aperture of 120 cm and a prism spectrograph having a dispersion of 60 Å/mm of Hδ. Eighty-nine Am stars, of which three are new, were classified according to the intensity of the K line and according to the intensity of the metallic lines. Finally, a new Ap star classified as Si-Cr is reported. (tr-auth)

23593 UBV PHOTOELECTRIC PHOTOMETRY OF HOT STARS OF "SELECTED AREAS" 40 AND 49 SITUATED NEAR THE GALACTIC PLANE. Bigay, J. H.; Garnier, R. (Observatorie, Lyon). Astron. Astrophys., Suppl Ser.; 1: 15-28(Jan 1970). (In French).

23594 UBV MEASUREMENTS IN "SELECTED AREAS" 100 and 112. Haug, U.; Walter, K. (Univ., Tuebingen, Ger.). Astron. Astrophys., Suppl. Ser.; 1: 29-33(Jan 1970). (In German).

23595 UBV OBSERVATIONS OF LUMINOUS STARS IN THREE MILKY WAY FIELDS (CASSIOPEIA, CAMELOPARDALIS, AND GEMINI). Haug, U. (Univ., Tuebingen, Ger. Kitt Peak National Observatory, Tucson, Ariz.). Astron. Astrophys., Suppl. Ser.; 1: 35-104(Jan 1970).

All stars contained in three fields of the "Luminous Stars in the Northern Milky Way" catalogues were observed in UBV with a 16-inch telescope at Kitt Peak National Observatory in 1964-1965. The results are assembled in a catalogue together with preliminary intrinsic colors, reddening values and distances. H II regions and other nebulae that may be connected with program stars are listed. Changes in brightness and colors of a few emission B stars were found by comparison with measurements by Hiltner. A statistical investigation of the preliminary intrinsic colors shows a dependency of the OB classification on brightness and different mean intrinsic colors in the three fields. The following results concerning the fields may be mentioned: (1) a reddening anomaly found by Reddish in Cas OB 5 was not confirmed, (2) there is a group of strongly reddened early-type stars near $l = 114°$, $b = -1°$, another one near $l = 139.5°$, $b = -1°$, (3) a number of possible members of Cam OB 3 (distance 3.5 kpc) was found, and (4) there are indications that Gem OB 1 consists of at least two different star groups with distances of about 1.2 and 2.2 kpc. (auth)

23596 NEW DOUBLE STARS DISCOVERED AT NICE WITH THE 50-cm TELESCOPE. Couteau, P. (Observatoire, Nice). Astron. Astrophys., Suppl. Ser.; 1: 105-14(Jan 1970). (In French).

A list of 100 double stars discovered at Nice in a program that began in 1967 is presented. (W.D.M.)

23597 THEORETICAL ENERGY LEVELS IN Fe IV. Warner, Brian; Kirkpatrick, Ronald C. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 147: 115-22(1970).

Predicted energy levels are given for the $3d^5$, $3d^4 4s$, and $3d^4 4p$ configurations of Fe IV, based on least squares adjustment of Slater parameters to fit known energy levels. (auth)

23598 ON THE VALUE OF R FOR NGC 2244. Dufour, R. J.; Lee, Paul (Louisiana State Univ., Baton Rouge). Astrophys. J.; 160: 357-61(Apr 1970).

Comparison of the surface brightness of the Rosette Nebula at 10 cm, Hβ, and Hγ indicates an average value of R to be 3.96. (auth)

23599 ATTEMPT TO DETECT NEUTRAL HYDROGEN IN PLANETARY NEBULAE. Thompson, A. R.; Colvin, R. S. (Stanford Univ., Calif.). Astrophys. J.; 160: 363-8(Apr 1970).

Six planetary nebulae were observed at the frequency of the 21-cm hydrogen line in an attempt to detect absorption of the thermal radio emission in neutral hydrogen in the outer parts of the nebulae. No evidence of such neutral gas was detected, and in two cases an

upper limit of 0.12 $M_\odot$ can be placed on the H I mass if the observations are interpreted in terms of a spherically symmetrical model and the temperature of the neutral gas is ≤100°K. (auth)

23600 COMMENTS ON STELLAR MASS LOSS. Kutter, G. S. (Univ. of Virginia, Charlottesville). Astrophys. J.; 160: 369-71 (Apr 1970).

The purpose of this note is threefold: (1) to point out a limitation of the hydrostatic equilibrium equation in stellar atmospheres, (2) to suggest momentum transfer from the radiation field to the gas as a mechanism for mass loss in early-type supergiants, and (3) to estimate the physical conditions determining whether this mechanism or coronal heating is responsible for mass loss. (auth)

23601 INSTABILITY OF A STELLAR ENVELOPE DUE TO RADIATION PRESSURE. Wentzel, Donat G. (Univ. of Washington, Seattle). Astrophys. J.; 160: 373-7 (Apr 1970).

The gradient of radiation pressure in a stellar envelope may cause a density inversion locally. The main instability of such an inverted layer is normal convection, not a Rayleigh–Taylor instability. Radiation also may damp the convection in some supergiant atmospheres that are normally considered to be convective. (auth)

23602 ON THE EVOLUTIONARY PHASE OF CEPHEIDS IN GLOBULAR CLUSTERS. Schwarzschild, M.; Haerm, R. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 160: 341-4 (Apr 1970).

The beginning of the helium shell burning phase has been computed through the first flash cycle for each of nine globular-cluster stars (differing in mass and initial composition). While seven of these stars remained on the red-giant branch throughout the cycle, two stars did not. The latter passed, after each flash, through a loop in the H–R diagram reaching well into the strip occupied by Population II Cepheids. It is suggested that the occurrence of these evolutionary loops might be the reason for the occurrence of Cepheids in globular clusters. (auth)

23603 ON THE INCIDENCE OF CEPHEIDS IN GLOBULAR CLUSTERS. Wallerstein, George (Univ. of Washington, Seattle). Astrophys. J.; 160: 345-7 (Apr 1970).

The available data on Cepheids in globular clusters are assembled and discussed. The data support the ideas presented by Schwarzschild and Härm because Cepheids are found only in globular clusters with blue horizontal branches. The paucity of Cepheids in Type II systems outside the Galaxy is also discussed. (auth)

23604 NON-LTE MODEL ATMOSPHERES. IV. RESULTS FOR MULTI-LINE COMPUTATIONS. Auer, L. H. (Yale Univ. Observatory, New Haven); Mihalas, Dimitri. Astrophys. J.; 160: 233-43 (Apr 1970).

Results are presented for model atmospheres in hydrostatic, radiative, and steady-state statistical equilibrium, including bound–bound transitions. These calculations allow for the effects of Hα, Hβ, Hγ, Pα, Pβ, and Bα. Stark profiles of Edmonds, Schlüter, and Wells are used to compute detailed line profiles. With the full non-LTE calculation the entire line profile, including the line core was predicted. The wings of Hα are found to weaken while those of Hγ remain unaffected by departures from LTE. Non-LTE effects strengthen the Paschen lines so that the comparison of Paschen lines with Balmer lines should provide a sensitive observational indicator of departures from LTE. Bα has an emission core, because of a rise in surface temperature, and may be a useful diagnostic tool in the analysis of real stellar atmospheres. The surface-temperature rise found in earlier work persists, the boundary temperature differing little from that obtained by allowing for Hα, Hβ, and Pα only. The energy distribution in the continuum is little affected by departures from LTE, except at very low gravities and in the unobservable Lyman continuum. (auth)

23605 THE EFFECTIVE TEMPERATURES OF SIX WOLF–RAYET STARS. Morton, Donald C. (Princeton Univ. Observatory, N. J.). Astrophys. J.; 160: 215-19 (Apr 1970).

The ratio of Lyman-continuum flux to visual flux for six WN-type Wolf–Rayet stars is derived from the free–free radio emission of surrounding nebulae and the apparent magnitudes of the stars. Comparison with the theoretical ratios obtained from model atmospheres which omit the emission lines, but include ultraviolet line blanketing where appropriate, gives estimates of the effective temperatures. Values around 50000°K are found for WN 4.5 and WN 5, 33000° for WN 6, and 23000° for WN 8. (auth)

23606 SUPERSONIC STELLAR WINDS IN EARLY-TYPE STARS. Marlborough, J. M.; Roy, J.-Rene (Univ. of Western Ontario). Astrophys. J.; 160: 221-4 (Apr 1970).

The effect on stellar winds of the mechanical force due to radiation is considered in general. If the flow velocity is initially subsonic in or near the star, it is shown that a supersonic stellar wind cannot arise as a result of the mechanical force due to radiation balancing or exceeding the gravitational force. (auth)

23607 DEPENDENCE OF CHROMOSPHERIC EMISSION UPON BOLOMETRIC LUMINOSITY FOR THE HYADES. Wilson, O. C. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 225-31 (Apr 1970).

Fluxes in the centers of the H and K lines were measured for sixty-five Hyades stars between F4 and K5. Analysis of these measures shows that, in terms of bolometric luminosity, the radiation in the chromospheric H and K emission lines increases by a factor of 2 between B−V = 0.45 and B−V = 1.25. Other results give the emission as a function of the local continuum, as well as the true emission ratios for stars in this color range. (auth)

23608 NUCLEOSYNTHESIS IN EXPLOSIVE OXYGEN BURNING. Truran, J. W.; Arnett, W. David (California Inst. of Tech., Pasadena). Astrophys. J.; 160: 181-92 (Apr 1970).

A preliminary investigation of the conditions appropriate to the synthesis of nuclei of intermediate mass ($28 \lesssim A \lesssim 42$) by explosive oxygen burning is presented. These calculations make use of the recent measurements of the $^{16}O + {}^{16}O$ reaction rate by Patterson, Winkler, and Spinka. The resulting abundance distributions are found to be sensitive to the temperature and density of the medium, to the time scale of expansion, and to the degree of neutron enrichment. Encouragingly good fits to both the elemental and isotopic abundance features in the silicon-to-calcium region are obtained for explosive oxygen burning in a rather restricted temperature range ($3.5 \times 10^9 \lesssim T \lesssim 3.7 \times 10^9$ °K) for densities in the range $10^5 \lesssim \rho \lesssim 10^6$ g cm^{-3}. (auth)

23609 BINARY FORMATION BY THREE-BODY COLLISIONS. Mansbach, Peter (Brandeis Univ., Waltham, Mass.). Astrophys. J.; 160: 135-45 (Apr 1970).

Keck's "variational method" is used to obtain an expression for the rate of formation of binaries due to stellar three-body collisions, under quite general conditions. In the solar neighborhood this rate is too small to account for any binaries. In globular clusters it could account for a few. The mass dependence and separation dependence of the three-body rate is also not in agreement with observations in the solar neighborhood, disproving the possibility that binaries were formed by this process but under different galactic circumstances. The general rate expression is also applicable to other problems, such as comet capture by a star or asteroid capture by a planet. An estimate of the latter, using available data, indicates that the rate is somewhat too low to account for Jupiter's outer moons if the third body is another asteroid. The third body might be a more massive satellite, however; this possibility is promising. (auth)

23610 INTRINSIC POLARIZATION OF STELLAR LIGHT FROM RX Boo, AB Cyg, AK Peg. Vartanyan, R. A. (Byurakan Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 51 (Spring 1968).

Translated from Astrofizika; 4: 152-4 (1968).

Preliminary polarimetric studies of these stars have shown an appreciable variation in the degree of polarization lying outside the range of experimental error (0.2%). Moreover, the degree of polarization is different in different parts of the spectrum. It is concluded that the origin of the intrinsic stellar polarization of cold supergiants (in stellar associations) and long-period variables is not the same. (W.D.M.)

23611 MAGNETIC MOMENT OF A MAGNETIZED ELECTRON GAS AND MAGNETIC FIELDS IN WHITE DWARFS AND NEUTRON STARS. O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Lett. Nuovo Cim.; 3: 218-20 (12 Feb 1970).

It was suggested by Lee et al. (1969) that the magnetization due to the magnetic moment associated with Landau levels will create in white dwarfs and neutron stars values of the magnetic induction B ranging from ~10^7G up to fields of the order of $B_c = m^2c^3/e\hbar = 4.4 \times 10^{13}$ G. Analytic arguments are presented that support their numerical results. (W.D.M.)

23612 ROTATION IN EVOLVING STARS. Kippenhahn, R.; Meyer-Hofmeister, E.; Thomas, H. C. (Univ., Goettingen, Ger. Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astron. Astrophys.; 5: 155-61 (Mar 1970).

With a simplified treatment of stellar rotation the evolutionary track of a star of 9 $M_\odot$ was computed from the main sequence to the exhaustion of helium. Two different assumptions on the distribution of angular momentum during evolution were made. In one (case α) angular momentum is conserved locally in radiative regions while in the other (case β) angular momentum is only con-

served in chemically homogeneous regions while solid-body rotation is assumed elsewhere. In both cases the star ends up with a fast spinning-core surrounded by a slowly rotating envelope. Some possible consequences of the rapid rotation of the central regions are discussed. (auth)

23613 PARTITION FUNCTIONS AND EQUILIBRIUM CONSTANTS FOR ScO, YO, AND LaO. Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Astron. Astrophys.; 5: 162-4(Mar 1970).

Partition functions and equilibrium constants for ScO, YO, and LaO were computed for temperatures between 1000 and 8000°K in steps of 500°K. It was assumed that the ground electronic state of all the three molecules is a doublet and the recent values for the spectroscopic constants and the dissociation energies were used. The excited electronic states A $^2\Pi$ and B $^2\Sigma$ were also considered and their contribution to partition function given. (auth)

23614 ON THE DEPENDENCE OF $M_v(K)$ ON METAL ABUNDANCE. Kjaergaard, P. (Univ. Observatory, Copenhagen). Astron. Astrophys.; 5: 165-6(Mar 1970).

A comparison of $M_v(K)$, based on the Wilson–Bappu method, and M_v, derived from trigonometric parallaxes was made for 142 G and K giant stars, that were divided into four groups according to metal content. It was found that the difference $M_v(K) - M_v$ is correlated with [Fe/H]; this result was interpreted as due to a dependence of $M_v(K)$ on metal content rather than to a systematic error in the observed trigonometric parallaxes. (auth)

23615 PHOTOMETRIC STUDY OF NOVA DELPHINI 1967 AND NOVA VULPECULAE 1968 NO. 1. Terzan, A. (Observatorie, Lyon). Astron. Astrophys.; 5: 167-70(Mar 1970). (In French).

The light curves (visual and photographic) of the novae Delphini 1967 and Vulpeculae 1968 No. 1 were drawn for periods going respectively from July 10, 1967 and April 15, 1968 to August 31, 1968. The maximum of brightness of Delphini 1967 was registered towards December 14, 1967. During the phases of decline, the diminution of brightness was particularly slow. An identical evolution of brightness was observed in two different spectral fields (m_v and m_{pg}). During the first ten days following its detection, Vulpeculae 1968 No. 1 showed fast fluctuations in the order of a magnitude. Then it started to decrease regularly, to reach, about the end of August 1968, the visual magnitude 9.2 and the photographic magnitude 10.0. The star becomes redder and redder. (auth)

23616 THE VARIABLE STAR BD + 63°141. Ljunggren, B.; Oja, T. (Astronomical Observatory, Uppsala). Astron. Astrophys.; 5: 113-15(Mar 1970).

The star BD + 63°141 was found to be a semiregular variable of the type SRd with a period of 134 ± 4 days. The range of variations is in V about 0.3m and in B–V about 0.15m. (auth)

23617 THE ZERO-POINT OF THE PERIOD–LUMINOSITY-RELATION OF CEPHEIDS. Geyer, U. (Astronomisches Rechen-Institut, Heidelberg). Astron. Astrophys.; 5: 116-26(Mar 1970).

The zero-point of the period–luminosity relation was redetermined by applying the method of secular parallaxes. The determination presented is based on proper motions, radial velocities, and photometric data of about a hundred Cepheids of Population I. This approach was encouraged by the availability of improved proper motions and photometric data. All proper motions were reduced to the system of FK4, and, for purposes of comparison, to the N30 system. The effects of galactic rotation, of incorrect precession, and of a motion of the equinox were taken into account. The radial velocities are discussed with respect to solar motion, differential galactic rotation, and K term. Adopting the slope of Kraft's period–luminosity relation, the zero-point is found to be −1.88 ± 0.45m. Kraft's value was −1.6m. With the slope of Fernie's period–luminosity relation the zero point is found to be −2.05 ± 0.45m. Fernie obtained the value −1.99m. (auth)

23618 THEORETICAL ENERGY LEVELS IN Fe V. Warner, B. (Univ. of Texas, Austin). Astron. Astrophys.; 5: 1-3(Mar 1970).

Predicted energy levels are given for the configurations $3d^4$ and $3d^34p$ in Fe v. (auth)

23619 HOMOGENEOUS MODELS FOR POPULATION I AND POPULATION II COMPOSITIONS. Copeland, H.; Jensen, J. O.; Joergensen, H. E. (Univ. Observatory, Copenhagen). Astron. Astrophys.; 5: 12-34(Mar 1970).

Zero-age models of intermediate and low masses with chemical composition parameters $0.60 \leq X \leq 0.90$ and $0.001 \leq Z \leq 0.030$ were studied. Coulomb interaction between the particles is taken into account and, also, the the H_2 molecule is included in the equation of state, the adiabatic gradient, and the specific heats. Especially the effects on the zero-age lines and on the mass–luminosity relation caused by the H_2 molecules are studied. The break in the observed mass–luminosity relation at luminosities around $M_{bol} \approx +7.5$ can be explained by changes in the models due to the H_2 molecules. Changes in the models due to changes in the mixing length were investigated. From the computed luminosities and effective temperatures, interpolation formulae giving the luminosity as function of mass and chemical composition were derived. Further, the position of the zero-age lines relative to a reference zero-age line is given as function of chemical composition. The relative positions of zero-age lines of Population I and Population II compositions are not independent of the choice of mixing length. Computed and observed zero-age lines are compared. The computed zero-age line for (X, Y, Z) = (0.70, 0.27, 0.03) and mixing length l = 1.5 H_P fits very well to the observed zero-age line in the spectral range A0 to K5 as the deviations are less than 0.2 magnitudes in luminosity or less than 200°K in effective temperature. For the M dwarfs the agreement between observed and computed zero-age lines is rather poor, corresponding to deviations in the effective temperatures of the order 400°K. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

23620 ARE PULSARS SINGLE STARS. Krat, V. A. (Pulkovo Observatory, Leningrad). Astrophys. Space Sci.; 6: 420-1(Mar 1970).

The possibility of two or more superdense bodies forming during the process of gravitational collapse is discussed. (W.D.M.)

23621 A SEARCH FOR A CONSISTENT MODEL FOR THE ELECTROMAGNETIC SPECTRUM OF THE CRAB NEBULA. Cowsik, R.; Pal, Yash; Rengarajan, T. N. (Tata Inst. of Fundamental Research, Bombay). Astrophys. Space Sci.; 6: 390-5 (Mar 1970).

An attempt is made to search for a consistent model to explain the electromagnetic spectrum of the Crab Nebula (Tau A). It is assumed that there is a continuous injection of electrons at the center of the Nebula with an energy spectrum $E^{-1.54}$ as evidenced by radio data. This spectrum must steepen to a slope larger than 2 at some energy E_1 in order to ensure that the energy input into electrons remains finite. The spectrum must also steepen beyond an energy E_c depending on the magnetic field because of synchrotron energy losses. Two types of models are considered: Class I, in which the whole Nebula is characterized by a uniform magnetic field, and Class II, in which besides the general field H_0, small filamentary regions of strong field H_s are postulated. In models of Class I, the best fit to the observed data is obtained when $E_1 > E_c$ and $H_0 \simeq 5 \times 10^{-4}$ gauss. However, this predicts a decrease in x-ray source size beyond ~40 keV. There are two possibilities of Class II model depending on the residence time of electrons in strong field regions being small or large. The former case explains the flattening in the optical spectrum. Experiments to distinguish between the various models are indicated. (auth)

23622 LOW-FREQUENCY SPECTRUM OF THE CRAB NEBULA. Bridle, A. H. (Queen's Univ., Kingston, Can.). Nature (London); 225: 1035-6(14 Mar 1970).

The spectral index (~1.75) of the compact low-frequency radio source in the Crab Nebula between 26.5 and 1407 MHz is the highest known for a galactic continuum source, and its brightness temperature of $\sim 10^{14}$ K at 38 MHz implies an unusual emission mechanism with a high volume emissivity. This high spectral index suggests that only a small fraction of the total radio luminosity of the source may have been observed in the frequency range studied so far, and evidence is presented that the high spectral index is maintained to 10 MHz, making corrections for absorption by free–free transitions of electrons in the intervening interstellar medium. The estimated spectrum of the Nebula between 10 and 15,500 MHz is shown graphically; the spectrum shows an enhancement of total radiation at low frequencies which is consistent with a power law extrapolation of the spectrum of the compact source to 10 MHz. Flux densities of the compact source are shown tabulated; the spectrum derived for the compact source can be represented by a power law of index $\alpha = 1.76 \pm 0.15$ from 10 to 1407 MHz, and the luminosity of the source over this frequency range is $\sigma\, 3 \times 10^{32}$ ergs/sec, which is about ten times that of the pulsar NP 0532 at radio frequencies but only one-tenth of its luminosity at optical frequencies. The brightness temperature at 10 MHz would be as high as $\sim 3 \times 10^{15}$K if the diameter were the same at this frequency as at higher frequencies, which leaves little doubt that the source cannot radiate by the electron synchrotron mechanism. It has been suggested that the emission may be proton synchrotron radiation emitted at a frequency below the electron gyrofrequency; this model is attractive, since it requires field and particle energies which are modest in comparison with the total energy supply of the Nebula, and which could be stabilized

by the gravitation of an object of mass ~1 $M_\odot$. The magnetic field and proton flux required on this model may be associated with the outer magnetosphere of the pulsar. This interpretation cannot be maintained, however, if there are electrons present in the region of the source, as these would absorb the proton radiation and there are other difficulties associated with this model. Alternatively, the high brightness temperature of the compact continuum source might be attributed to coherent plasma oscillation or to radiation from a synchrotron maser. In either case the characteristic frequency associated with the mechanism must be <10 MHz and the total energy output must appreciably exceed the 3×10^{32} ergs/sec estimated from the present observations, unless the emission is anisotropic. Relationship of the compact source with NP 0532 is discussed, and further experimental studies are indicated. (UK)

23623 HOW SIGNIFICANT ARE THE SHARP PEAKS IN THE FREQUENCY DISTRIBUTION OF QSO REDSHIFTS? Wesselink, A. J. (Yale Univ. Observatory, New Haven). Nature (London); 225: 927-8(7 Mar 1970).

Studies by Plogemann et al. (Nature 224: 875 (1969)) seemed to show that quasar redshifts are not intrinsic, and that there is no significant evidence for periodicity of peaks in the redshift distribution (z). The present author, however, concludes that the well known peak at $z = 0.060$ cannot be due to chance, although there is some uncertainty of the significant level. On the other hand, the conclusion by Burbidge (Nature 222: 21 (1969)) that the peak at $z = 1.95$ is highly significant was not confirmed. It is shown that this discrepancy is due to the interpretation of the statistics. The gross frequency distribution of redshifts for $0.02 < Z < 2.18$ with $\Delta Z = 0.24$ is shown graphically; lack of uniformity is evident and a complete explanation is likely to involve a number of factors with observational selection as a prominent contributor. The reality of peaks in the z distribution was examined; 184 redshifts with $0.024 < Z < 2.192$ were analyzed for the presence of peaks. No significant evidence was found for peaks (other than that at 0.060), previously pronounced significant. None of the five objects with $Z = 0.060$ seems to show any common characteristic other than redshift. (UK)

23624 OBSERVATIONS OF COSMIC RADIO SOURCES AT 60 Mc. Aslanyan, A. M.; Dagkesamanskii, R. D.; Kozhukhov, V. N.; Malumyan, V. G.; Sanamyan, V. A. (Byurakan Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 39-42(Spring 1968).

Translated from Astrofizika; 4: 129-34(1968).

The flux densities of 100 radio sources at 60 Mc were measured with the aid of the east-west arm of the wide-band Serpukhov radiotelescope. (auth)

23625 QUASI-SINUSOIDAL OSCILLATION IN ARRIVAL TIMES OF PULSES FROM NP 0532. Richards, D. W. (Arecibo Observatory, Puerto Rico); Pettengill, G. H.; Counselman III, C. C.; Rankin, J. M. Astrophys. J.; 160: L1-6(Apr 1970).

In 1969 from May 10 until September 16, times of arrival of radio pulses from the pulsar NP 0532 in the Crab Nebula had a quasi-sinusoidal oscillation of 760 μsec amplitude from peak to peak with an 11-week period, in addition to previously reported secular deceleration. (auth)

23626 OBSERVATIONS OF THE ANOMALOUS MICROWAVE RECOMBINATION LINE AT 11 CM WAVELENGTH. Zuckerman, B.; Palmer, Patrick (Univ. of Maryland, College Park). Astron. Astrophys.; 4: 244-7(Feb 1970).

The anomalous microwave recombination line at 11 cm wavelength was detected in NGC 2024, Orion A, and IC 1795 and not detected in M 17, W 51, and W 49. In NGC 2024, the peak antenna temperature of the anomalous line increases between 6- and 11-cm wavelengths. This increase is not expected if the line is emitted under the conditions of local thermodynamic equilibrium. (auth)

23627 SLOW PERIODIC VARIATIONS IN PULSARS. Staelin, D. H. (Massachusetts Inst. of Tech., Cambridge); Ewing, M. S.; Price, R. M.; Sutton, J. M. Astrophys. J.; 160: L7-10(Apr 1970).

The pulsars MP 0031 and CP 1919 exhibit periodicities in pulse intensity of approximately 2 and 6 min, respectively. In each pulsar strong bursts of pulses are often followed by one or more similar bursts spaced at the appropriate 2- or 6-min period. Sometimes there is more than one burst per 2- or 6-min period, and this combination of bursts then repeats as a unit until the component bursts independently diminish. These long "circulation periods" are approximately equal to the time required for the marching subpulses observed in each pulsar to march one fundamental pulsar period. Radio-emission models involving plasma waves circling around pulsars are favored by these results. (auth)

23628 NEUTRON STAR CRUSTS AND ALIGNMENT OF MAGNETIC AXES IN PULSARS. Goldreich, Peter (California Inst. of Tech., Pasadena). Astrophys. J.; 160: L11-15(Apr 1970).

The electromagnetic torque that brakes the rotation of a magnetic neutron star also tends to align the magnetic axis with the rotation axis. For fluid stars the time scale for alignment is comparable to the time scale for rotational braking. However, the presence of a crystalline mantle impedes the alignment of the magnetic axis with the rotation axis. Actual rates of alignment are probably determined by creeping or cracking of the solid mantle. (auth)

23629 SEARCH FOR POLARIZATION IN THE X-RAY EMISSION OF THE CRAB NEBULA. Wolff, R. S.; Angel, J. R. P.; Novick, R.; Vanden Bout, P. (Columbia Univ., S. C.). Astrophys. J.; 160: L21-5(Apr 1970).

A rocket-borne x-ray polarimeter was flown in search of polarization in Taurus X-1. Although a result consistent with zero polarization was obtained, the statistics were such that x-ray polarization comparable in magnitude to that of radio or optical emission cannot be excluded. (auth)

23630 MULTIPLE ABSORPTION REDSHIFTS IN QUASI-STELLAR OBJECTS. Rees, M. J. (Inst. for Advanced Study, Princeton, N. J.). Astrophys. J.; 160: L29-32(Apr 1970).

The multiple absorption redshifts observed in PKS 0237-23, Ton 1530, and other objects may arise from gaseous filaments trapped within rapidly expanding remnants of radio clouds ejected from QSOs. (auth)

23631 FURTHER SPECTROSCOPIC OBSERVATIONS OF QUASI-STELLAR OBJECTS AND RADIO GALAXIES. Burbidge, E. Margaret (Univ. of California, San Diego). Astrophys. J.; 160: L33-9(Apr 1970).

Spectroscopic observations of nineteen quasi-stellar objects and five radio galaxies were made with the Lick 120-inch telescope. Redshifts were determined for fourteen QSOs and all of the radio galaxies; in five QSOs only one emission was measured. Four and possibly five of the QSOs of largest redshift have absorption lines. In the three cases analyzed, the absorptions are at redshifts close to the emission-line redshifts, and presumably arise in gas associated with the QSO. The QSO 5C 2.56, with probably the largest observed redshift, has become extremely faint and should be continuously monitored. Some misidentified radio sources are listed. (auth)

23632 RADIO EMISSION FROM QUASI-STELLAR OBJECTS. Grueff, G. (Laboratorio Nazionale di Radioastronomia, Bologna). Astrophys. J.; 160: L41-2(Apr 1970).

Some recent identifications of BSOs with faint radio sources are questioned. (auth)

23633 A HIGH-RESOLUTION MAP OF CASSIOPEIA A AT 2.7 GHz. Rosenberg, Ivan (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 215-30(1970).

Observations of Cas A (3C 461) were made using the Cambridge One-mile telescope at a frequency of 2695 MHz with a beamwidth of 12″ × 14″ arc. The high resolution revealed complex structure in the source and some of the spurs observed previously at a lower resolution were found to be separated compact components of high emissivity. By comparing the new observations with earlier ones made at 1407 MHz, variations of structure with frequency across the source were found, with spectral indices higher on average on the west half of the source than on the east. Comparisons with optical photographs show a remarkable correlation between the gaps in the radio shell and some of the high velocity optical filaments. Estimates of some physical parameters of the main source and of the compact components are derived. (auth) (UK)

23634 SHORT-TERM PERIODIC VARIATIONS FOLLOWING AN OPTICAL FLARE OF SCO X-1. Gribbin, J. R.; Feldman, P. A.; Plagemaun, S. H. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London); 225: 1123-4(21 Mar 1970).

A detailed investigation was made on the "flickering" of the optical source associated with Sco X-1 using power spectrum analysis. No evidence was found for stable periodic structure when the time series resulting from a whole night's observations was analyzed. An analysis of shorter stretches of observations, chosen so that no long-scale flaring occurred during the selected periods, appeared to reveal periodic structure at one or more frequencies, corresponding to components with amplitudes in the range of 0.1 to 0.5% of the mean intensity over the appropriate interval. As a result a closer study was made at certain regions of the date. It would be expected that long-scale flaring of the source would influence the small-scale flickering,

and the investigation described was concentrated on the fairly smooth set of data immediately following a large and well-defined flare which occurred on the night of April 3, 1967, with a view to looking for any detectable influence of the flare on the flickering. It was clear that the flare had a pronounced effect on the smaller and more rapid variation, but it is not clear how energy is transferred from a flare to produce periodic flickering, and a discussion of possible models must await completion of more detailed studies. The presence of a large peak in the power spectrum at 0.006 Hz is emphasized. (UK)

23635 IMPROVED PARAMETERS FOR SEVEN PULSARS. Manchester, R. N. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 225: 1124-5(21 Mar 1970).

The observations described were made in order to determine more accurate declinations and periods for several pulsars using the 300-ft transit telescope of NRAO. Mean pulse energies at 410 MHz were also measured, and the effective pulse width was calculated. The observations were made during Nov. 17 to 23, 1969, and it was possible to track a source for up to 40 min. Results are tabulated for seven pulsars. (UK)

23636 X-RAY SCATTERING BY GRAINS IN THE DIRECTION OF THE CRAB PULSAR AND SCO XR-1. Bowyer, C. S.; Mack, J.; Lampton, M. (Univ. of California, Berkeley). Nature (London); 225: 1125-7(21 Mar 1970).

Most of the x-ray emission from the Crab Nebula is from a diffuse cloud approximately 100″ in angular size, and about 10% of the total x-ray flux is observed in pulsed form, presumably from the optical pulsar. It has been suggested (Slysh, Nature, 224: 159 (1969)) that all the x-ray flux originates in pulsed form at the pulsar and that scattering by grains obliterates the time coherence and produces the observed angular size. The hypothesis is discussed from the observational point of view. The parameters needed to specify x-ray scattering from grains are specified and discussed. Amongst conclusions reached is that the optical effects of grains sufficient to produce the observed x-ray scattering are incompatible with reddening data on the Nebula. It is also concluded that the x-ray scattering hypothesis for the Crab is at variance with the x-ray data obtained on Sco XR-1. Grains considered are a graphite core of 0.05-μm radius surrounded by an ice mantle of sufficient thickness to produce the indicated grain size and also SiO_2 grains. (UK)

23637 BREMSSTRAHLUNG RADIATION IN AN INTENSE MAGNETIC FIELD AND EMISSION FROM PULSARS. Chiu, H. Y.; Canuto, V. (Goddard Space Flight Center, New York). Nature (London); 225: 1230-1(28 Mar 1970).

Reference is made to Simon and Strange (Nature 224: 49(1969)) who argued that one of the processes (bremsstrahlung in the $0 \rightarrow 0$ transition in a magentic field) proposed by the present authors (Phys. Rev. Lett. 22: 415(1969)) as the chief mechanism of pulsar emission cannot give rise to a negative absorption coefficient. It is pointed out that this argument was based on a formula for the absorption coefficient which is valid only for synchrotron radiation. Also, the expression employed for the emissivity is applicable only to the high quantum number case. When the correct formula for the absorption coefficient is used in conjunction with the emissivity valid for the $0 \rightarrow 0$ transition, the absorption coefficient can become negative and amplification of electromagnetic waves is possible from the $0 \rightarrow 0$ bremsstrahlung process. Laser amplification of radiation can take place. (UK)

23638 MEASUREMENTS OF THE INTEGRATED LINEAR POLARIZATION OF DISCRETE RADIO SOURCES AT 610 MHz. Kronberg, P. P.; Conway, R. G. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 149-60(1970).

Values of the integrated degree of linear polarization at 610 MHz are listed for ninety-one radio sources. The results show an overall trend to lower polarizations than at wavelengths of 21 cm and 10 cm. For the majority of sources measured, the degree of polarization at 610 MHz is not affected by depolarization in the Galaxy. Correlations with optical identification and radio spectral index are discussed. (auth) (UK)

23639 A REVISED RADIO-FREQUENCY SPECTRUM FOR H_2^+. Somerville, W. B. (London Univ.). Mon. Notic. Roy. Astron. Soc.; 147: 201-5(1970).

New calculations of the second order interaction d″ in the hyperfine structure of H_2^+ suggest that d″ is not negligible, contrary to the recent conclusion of Luke (1969). Even for d″ = 0, Luke's results are incorrect, due to the neglect of state mixing. The calculations are related to the results of laboratory experiments and revised frequencies and transition probabilities are presented. (auth) (UK)

23640 INTERNAL KINEMATICS OF TWO BRIGHT H II REGIONS. Smith, Malcolm G. (Kitt Peak National Observatory, Tucson, Ariz.); Weedman, Daniel W. Astrophys. J.; 160: 65-74 (Apr 1970).

A pressure-scanned, Fabry–Pérot interferometer was used to determine profiles of the [O III] λ5007 emission line in the Orion Nebula and M8 with a spectral resolution of 4 km sec^{-1} and angular resolutions varying from 7″ to 21″. Most of the turbulent motions in the nebulae were found to be subsonic, with an average most probable speed of 7.6 km sec^{-1} in the Orion Nebula. Line profiles from two condensations (the Hourglass) in the center of M8 indicated that these condensations are apparently expanding, and slitless spectra were used to derive the density and structure of the Hourglass. (auth)

23641 SEARCH FOR ^{18}OH IN EMISSION. Ball, John A. (Harvard College Observatory, Cambridge); Penfield, Hays. Astrophys. J.; 160: 349-51(Apr 1970).

A search was made for radio emission from ^{18}OH at 1584.33 MHz in the direction of NML Cygnus, VY Canis Majoris, and W3–OH at velocities that correspond to the 1612 MHz emission from ^{16}OH in these sources. No ^{18}OH emission was found. For NML Cygnus, the upper limit is less than the terrestrial isotopic abundance ratio times the strength of the 1612-MHz emission. (auth)

23642 HIGH-RESOLUTION RADIO INTERFEROMETRY AT 610 MHz. Jauncey, D. L. (Cornell Univ., Ithaca, N. Y.); Bare, C. C.; Clark, B. G.; Kellermann, K. I.; Cohen, M. H. Astrophys. J.; 160: 337-9(Apr 1970).

High-resolution interferometer observations, with a baseline of 5.2×10^6 wavelengths at 610 MHz, are reported. Fringes were detected at a level of greater than 1 flux unit on twelve radio sources. (auth)

23643 A MEASUREMENT OF THE OPTICAL AND X-RAY EMISSION FROM SCORPIUS X-1 AND THE X-RAY DIFFUSE BACKGROUND. Toor, A. (Univ. of California, Livermore); Seward, F. D.; Cathey, L. R.; Kunkel, W. E. Astrophys. J.; 160: 209-13(Apr 1970).

Another simultaneous measurement of the optical and x-ray emission from Sco X-1 was made. A rocket-borne scintillation counter was used to measure the x-ray spectrum from 4 to 40 keV. The optical intensity at the time of the x-ray measurements was B = 12.97 mag. The x-ray spectrum looks like thin-source thermal bremsstrahlung with an apparent plasma temperature of 7 ± 1 keV. These data are compared with previous measurements of x-ray and optical emission. It is possible that total energy emission from Sco X-1 follows the B-magnitude in a nearly linear fashion. The diffuse x-ray background was measured in the energy range 4 to 70 keV. A shutter arrangement made it possible to correct accurately for the cosmic-ray contribution to the background. This measurement agrees with the previously reported spectrum. (auth)

23644 X-RAY CHARACTERISTICS OF THREE SUPERNOVA REMNANTS. Gorenstein, P.; Kellogg, E. M.; Gursky, H. (American Science and Engineering, Inc., Cambridge, Mass.). Astrophys. J.; 160: 199-208(Apr 1970).

Spectral analyses were made of the x-ray data ($1 \leq E \leq 10$ keV) obtained during a rocket flight from two sources that have been identified with Cas A and SN 1572 (Tycho's supernova). The Crab Nebula was also observed. Relative observed counting rates from the Crab, Cas A, and SN 1572 are 1, 0.1, and 0.04, respectively. The Crab is found to have the hardest spectrum of the three. Extrapolation of the radio spectrum of Cas A and SN 1572 results in agreement with the measured intensity at 1 keV, although the spectrum appears to have steepened in the x-ray region. Interstellar attenuation affects the spectrum of Cas A to an extent that is consistent with or perhaps less than presently accepted values. Comparison of x-ray and 21-cm absorption effects in the spectrum of the supernova remnants implies that the concentration of oxygen and neon relative to hydrogen along the line of sight to the sources is at most equal to presently accepted values of cosmic abundances. (auth)

23645 A COMPARISON OF A 15.4-GHz MAP OF M16 WITH THE OB STARS IN THE CLUSTER NGC 6611. Felli, M.; Churchwell, E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 160: 43-9(Apr 1970).

The 15.4-GHz map of M16 indicates the existence of three separate components. The flux density of each component was used to calculate the Lyman-continuum flux required to give the measured radio-flux density. A comparison with the Lyman-continuum flux emitted by the OB stars in the nebula indicates that not all the sources of ionization have been identified. (auth)

23646 MOTIONS AND PHYSICAL CONDITIONS INSIDE DUST CLOUDS. Heiles, Carl (Univ. of California, Berkeley). Astrophys. J.; 160: 51-8(Apr 1970).

OH profiles were obtained at various positions within four dust clouds. No variation of velocity within any cloud is visible, an observation which indicates little rotation. All clouds show profiles which are probably double or multiple; the lack of velocity variation with position permits the conclusion that the components arise from independent entities. Hydrogen 21-cm line profiles for one cloud show a dip which is attributed to self-absorption. From these and previous work it is shown the density is high and the kinetic temperature low, about 5°K. Much molecular hydrogen exists in these clouds, and the relative motions of the velocity components are supersonic. OH in clouds of very low temperature has not passed through a shock wave; OH in one of the clouds shows a high excitation temperature (greater than 9.6°K), possibly a result of supersonic collisions in the past. (auth)

23647 ADDITIONAL OCCULTATION STUDIES OF WEAK RADIO SOURCES AT ARECIBO OBSERVATORY: LIST 4. Lang, Kenneth R. (Arecibo Observatory, Puerto Rico); Sutton, J.; Hazard, C.; Gulkis, S. Astrophys. J.; 160: 17-23(Apr 1970).

Positions, structures, and optical identifications are derived from the lunar-occultation observations of ten weak radio sources. (auth)

23648 EXCITATION OF C III λ1909 AND OTHER SEMIFORBIDDEN EMISSION LINES IN QSOs AND NEBULAE. Osterbrock, D. E. (University Coll., London). Astrophys. J.; 160: 25-30 (Apr 1970).

Newly calculated collision strengths for $2s^2\ ^1S - 2s2p^3P$ of C^{+2} and other isoelectronic ions are integrated over a Maxwellian distribution to give effective collision strengths. The fraction of excitations leading to emission of a line photon is calculated in various density ranges. The possibility of determining electron densities in the range 10^5 to 10^8 cm^{-3} from the relative strengths of the two components $^1S_0 - ^3P_{1,2}$ is pointed out. (auth)

23649 IMPROVED RIGHT ASCENSIONS FOR 0.9 STERADIANS OF 4C CATALOGUE. Clarke, T. W.; Frater, R. H.; Large, M. I.; Munro, R. E. B.; Murdoch, H. S. (Sydney Univ.). Aust. J. Phys., Astrophys. Suppl.; No. 10, 1-36(Aug 1969).

The east-west arm of the Molonglo radio telescope has been used to determine more precisely the right ascensions of the 4C sources from 10h 30m to 18h 30m and south of declination +18°. A description is given of the procedure used to analyze the data, which were digitally recorded on magnetic tape. For a large proportion of the stronger sources the accuracy of the right ascensions is approximately 2 sec of arc. (Australia)

23650 PARKES HYDROGEN-LINE SURVEY OF THE MILKY WAY. II. THE SECTION $l^{II} = 296°$ TO 63°.5, $b^{II} = -2°$ TO +2°. Kerr, F. J. (Maryland Univ., College Park). Aust. J. Phys., Astrophys. Suppl.; No. 9, 1-147(Jul 1969).

Results of a survey with the Parkes 210-ft telescope and a 48-channel receiver of 21-cm line radiation from a major part of the galactic disk are presented. Included are (i) 34 velocity-longitude contour maps covering the galactic equator from $l^{II} = 296°$ to 63.5°; and (ii) 98 velocity-latitude maps for various constant longitude lines between 300° and 60°. (Australia)

23651 ACCURATE FLUX DENSITIES AT 5009 MHz OF 753 RADIO SOURCES. Shimmins, A. J.; Manchester, R. N. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 8, 1-53(Jun 1969).

The flux densities at 5009 MHz for 753 radio sources from the Parkes catalogues were determined. The sources are between declinations +27° and −90° and are mostly extragalactic. In general, the accuracy of the peak flux density is ±0.02 f.u. due to receiver noise and confusion; increasing to ±2% of the flux density due to uncertainty in receiver gain and dish efficiency (r.m.s. errors). Because of the small beam width of 4.0′ arc, many of the sources are partly resolved. To obtain the integral flux density, size-correction factors have been calculated for all sources for which information on the structure is available. (Australia)

23652 PARKES CATALOGUE OF RADIO SOURCES: DECLINATION ZONE +20° TO -90°. Ekers, Jennifer A. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 7, 1-75(Apr 1969).

A catalogue is presented of 1780 radio sources observed between declinations +20° and −90° with the Parkes 210-ft telescope. It replaces the earlier Parkes Catalogue that appeared as four publications for different declination zones. The data of the original version have been improved by the inclusion of more precise positions, more accurate flux densities, and additional information concerning polarization, source structure, and optical identifications. (Australia)

23653 MEASUREMENTS OF ABSOLUTE SKY BRIGHTNESS TEMPERATURES AT 320 AND 707 MHz. Wall, J. V.; Chu, T. Y.; Ten, J. L. (Toronto Univ.). Aust. J. Phys.; 23: 45-57 (Feb 1970).

Measurements of absolute sky brightness temperatures have been carried out over limited regions of the sky at 320 and 707 MHz. At both frequencies, low resolution horn antennas were used with Dicke switched receivers. Zero levels were determined with a substantial load at the temperature of liquid nitrogen. The antenna temperatures were reduced to full beam brightness temperatures by removing ground, side lobe, and atmospheric contributions. The results indicate a change in spectrum in this frequency range consistent with addition to the galactic nonthermal radiation of isotropic radiation having a thermal spectrum and a brightness temperature of 3°K. A power law spectral index of -0.45 ± 0.15 is obtained for the galactic nonthermal emission. (Australia)

23654 POLARIZATION OF RADIO SOURCES. II. OBSERVATIONS OF EXTENDED RADIO SOURCES. Davies, R. D. (Manchester Univ., Eng.); Gardner, F. F. Aust. J. Phys.; 23: 59-78(Feb 1970).

A polarization survey at 11.3-cm wavelength with beamwidth 7.5′ × 7.2′ arc (supplemented in some case by measurements at 21.3 cm) has been made of 13 extended extragalactic sources and of 7 extended galactic objects presumed to be supernova remnants. Particular attention was paid to instrumental effects. After correction for these effects the observed polarization distributions for all the extragalactic sources were satisfactorily fitted to double or triple component models; in half the cases magnetic-field configurations could be derived. Detectable polarization was found at 11.3 cm for all the galactic sources, but that a 21.3 cm was generally weak. This depolarization could occur in the interstellar medium. Measurements of Taurus A made at both 6 and 11.3 cm showed that the polarized region was 2′ arc in extent and was displaced from the center of the object. (Australia)

23655 RADIO OBSERVATIONS OF FOUR SUPERNOVA REMNANTS. Caswell, J. L. (Dominion Radio Astrophysical Observatory, Penticton, B. C.). Aust. J. Phys.; 23: 105-8 (Feb 1970).

Contour maps are presented of 4 radio sources at 178 and 38 MHz. (Australia)

23656 DE-CONVOLUTION OF BARELY RESOLVED RADIO SOURCES MAPPED WITH AERIAL BEAMS OF ELLIPTICAL CROSS SECTION. Wild, J. P. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 23: 113-15(Feb 1970).

A solution is given for estimating the size of a barely resolved angular source, assuming that the observed brightness distribution, and the power polar diagram of a radio telescope can be adequately represented by elliptical-Gaussian functions. (Australia)

23657 PROPERTIES OF H II REGIONS OBTAINED FROM NON-LTE ANALYSIS OF RADIO RECOMBINATION LINE DATA. Hjellming, R. M.; Davies, R. D. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 5: 53-67(Mar 1970).

A non-LTE analysis of all available α, β-, γ-, δ-, and ϵ-radio recombination line data determines electron temperatures, electron concentrations, and emission measures for the dominant emitting gas in seven H_{II} regions. For the Orion Nebula, M17, W51, and W3, the radio lines are emitted from extremely small (0.003 to 0.02 pc in depth), dense (2.5×10^4 to 10^5 electrons per cm^3) regions having temperatures of the order of 10^4°K. (auth)

23658 AN ELONGATED NEUTRAL-HYDROGEN EMISSION FEATURE IN SCORPIUS AND OPHIUCHUS. Sancisi, R.; van Woerden, Hugo (Sterrenkundig Laboratorium, Groningen, Netherlands). Astron. Astrophys.; 5: 135-9(Mar 1970).

Hydrogen 21-cm line profiles in the Sco-Oph region show a narrow emission feature having a radial velocity of −12 km/s with respect to the local standard of rest. The feature extends over a large area of sky; it has a filamentary shape and considerable internal structure. Comparisons with interstellar sodium lines place an upper limit of 170 pc on its distance from the Sun. (auth)

23659 THE ALGOL SYSTEM RV OPHIUCHI AND THE VARIATION OF ITS LIGHT CURVE WITH TIME. Walter, K. (Univ., Tuebingen, Ger.). Astron. Astrophys.; 5: 140-8(Mar 1970).

Photoelectric observations of the Algol variable RV Ophiuchi in B and V are discussed and a photometric solution for this system is given. The difficulty with which Dugan was confronted when he

was determining the ratio of radii of the components occurred in a similar manner but could be removed by the subtraction of a small amount of foreign light. The present V curve and the light curve observed visually by Dugan 55 years ago show distortions which have much in common but also distinct differences. A model of a gas stream is given by which the chief characteristics of the light curves are represented. Besides effects of absorption, it is emission from the region where the gas stream hits the A star that determines essentially the light curve outside eclipses. (auth)

23660 POTENTIAL FLOW PERTAINING TO BINARY SYSTEMS. Sobouti, Y. (Univ. of Pennsylvania, Philadelphia. Pahlavi Univ., Iran). Astron. Astrophys.; 5: 149-54(Mar 1970).

Gas flow arising from the orbital motion of stars in a close binary system is a consequence of equations of fluid motion and is inevitable. The velocity of flow is of the order of and less than the orbital velocities. It has the same magnitude and topological structure as most radial velocities derived from observations of spectral lines whose origin lies in the gaseous envelope. (auth)

23661 A STUDY OF TWO BRIGHT RIMS IN THE NORTH AMERICA NEBULA. Louise, R. (CNRS, Marseille). Astron. Astrophys.; 5: 35-6(Mar 1970).

The electron temperature was measured in both bright rim D (following the notation of Pottasch, 1956) and the central part of the North America Nebula (NGC 7000) by Courtès et al. (1968) and by Louise and Monnet (1969), respectively. It is therefore possible to measure the electron density at the top of the bright rim by observing its brightness in Hα. A plate of NGC 7000 was taken with a narrow interference filter centered on the Hα line. From this, both the electron density and the brightness profile of the bright rim are derived. The results are in good agreement with the predictions of Pottasch (1965). It was found that the bright rim profile presented a double peak. (auth)

Solar Phenomena

23662 (CTO-705) THERMAL MODEL OF THE ACTIVE REGION OF THE SOLAR CORONA. Beigman, I. L.; Vainshtein, L. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Culham Lab., Abingdon, Eng., from Preprint No. 94. 26p. Dep. CFSTI (U. S. Sales Only).

The x-ray fluxes in the resonance lines $\lambda < 25$ Å of the most abundant ions in the solar corona were calculated for a wide range of temperatures (0.2 to 18) $\times 10^6$ °K. The rates of excitation, ionization, and recombination (photo- and dielectronic) obtained previously by numerical methods were used. The calculated fluxes were used to analyze experimental data on the emission of the active regions in the spectral range $\lambda < 25$ Å. It was assumed that the photospheric abundance of C, N, and O in the corona is correct and the abundances of Ne, Mg, and Fe were calculated from experimental data. The analysis was based on a thermal model of the active region. The available data can be divided into two groups. It is shown that all cases can be described by a model of the active region with a temperature $T = 2.5$ to 3 (in units of 10^6 °K) the only difference being in the emission measure $Y \equiv N_e^2 V/3.2 \times 10^{49}$ cm^{-3} = 0.07 to 0.16. To describe the observations one has to adopt a smooth variation of T up to T_1 and the estimate $T = 4$ is obtained from the relative fluxes Fe XVII/Fe XVIII. The abundances proposed by various authors are compared. The total x-ray fluxes in the intervals $\lambda - \lambda + \Delta\lambda$ for the spectral range $\lambda < 25$ Å are calculated for the different sets of abundances and temperatures at $\Delta\lambda = 0.2$ and 1 Å. (auth)

23663 (NP-18099) APOLLO 11 SOLAR WIND COMPOSITION EXPERIMENT: FIRST RESULTS. Buehler, F.; Eberhardt, P.; Geiss, J.; Meister, J. (Bern Univ. (Switzerland). Physikalisches Institut); Signer, P. (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 14 Nov 1969. 13p. Dep. CFSTI (U. S. Sales Only).

The ^{4}He solar-wind flux during the Apollo 11 lunar surface excursion was $(6.3 \pm 1.2) \times 10^6$ atoms/cm^2 sec. The solar-wind direction and energy are essentially not perturbed by the Moon. Evidence for a lunar solar-wind albedo was found. (auth)

23664 RESONANCE FLUORESCENCE OF THE CN FREE RADICAL. Meyer, J. A.; Nicholls, R. W. (York Univ., Toronto). Nature (London); 225: 928-9(7 Mar 1970).

Cometary emission spectra show features of such diatomic radicals as CN, C_2, OH, CO^+ and N_2^+ which almost certainly arise from photon or corpuscular irradiation of polyatomic species in the comet head, and the spectra are almost certainly excited by resonance fluorescent excitation by solar photons. Little laboratory work has been done on the kinetics of excitation processes of cometary spectra; in the present communication some recent studies on the fluorescent excitation of CN in a static system are described. Free CN was produced by gas phase photolysis of ICN, the dissociation products being I^2 and vibrationally unexcited $CN(X^2\Sigma)$. The Xe lamp employed not only photolysed ICN but also excited it to the $B^2\Sigma$ state, from which fluorescence of the bands of the violet $B^2\Sigma - X^2\Sigma$ system was observed with a photoelectric-scanning 0.25-m monochromator. The fluorescence signal consisted mostly of bands near 3883 Å. Mechanisms related to the fluorescent excitation of CN are discussed. Recombination was not an important process at the experimental pressures. On the other hand, diffusion and quenching were major radical sinks. (UK)

23665 LOW-ENERGY SOLAR PROTONS. Lutsenko, V. N.; Pisarenko, N. F. Kosm. Issled.; 7: 711-30(Sep-Oct 1969). (In Russian).

Experimental data on low-energy solar protons are reviewed and phenomenological classification of this particle flux is given. Simulated models of propagation of low-energy proton fluxes in the interplanetary media are reviewed, and properties of the interplanetary media obtained on the basis of solar flux data are evaluated. (tr-auth)

23666 INTERACTION BETWEEN INTERSTELLAR HYDROGEN AND THE SOLAR WIND. Blum, P. W.; Fahr, H. J. (Institut fuer Astrophysik und Extraterrestrische Forschung, Bonn). Astron. Astrophys.; 4: 280-90(Feb 1970).

A consistent calculation concerning the interplanetary density distribution of cold hydrogen of interstellar origin is given. The calculations take account of the macroscopic velocity v_θ of the interstellar gas relative to the solar system, of the focusing effect of the gravitational field of the Sun and of loss processes by charge exchange with solar wind protons and euv-ionization. The results show a density decrease from outer to inner regions of the system that depends on the solar euv-flux. For conditions of low solar activity the density of cold hydrogen at the orbit of the Earth is found to be about one third of the density n_θ in the neighborhood of the solar system. During the solar cycle the depth of penetration of interstellar hydrogen into the solar system varies between 6 and 1 AU. The production of secondary fast hydrogen by charge exchange processes of the cold hydrogen with solar wind protons has been investigated. The density of fast secondary neutrals reaches a maximum at a certain distance from the Sun. For a solar wind proton flux of $1.5 \cdot 10^8$ cm^{-2} s^{-1} at the orbit of the Earth this maximum is located near 1 AU. The results concerning density and flux of secondary neutrals give some indication that the magnetic shock front should be located near 80 AU. Its exact location is influenced by the density n_θ and the velocity v_θ of the interstellar gas. Furthermore, estimates show that the production of fast secondary neutrals in a region of turbulent plasma beyond this shock front would not essentially change the results presented in this paper. (auth)

23667 SOLAR-NEUTRINO FLUXES WITH RECENT CORRECTIONS TO OPACITY. Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Ulrich, Roger K. Astrophys. J.; 160: L57-60(Apr 1970).

Improved calculations of the rate of solar-neutrino capture for experiments with ^{37}Cl and ^{7}Li are presented. There is a sizable discrepancy between the calculated values and the experimental upper limit of Davis et al. The primordial helium abundance inferred from the relevant solar models ranges from $Y = 0.22$ to $Y = 0.26$. The expected neutrino capture rates in the ^{37}Cl and ^{7}Li experiments and the inferred primordial helium abundance are sensitive to the present-day photospheric abundance ratio of iron to hydrogen. (auth)

23668 THE DIATOMIC MOLECULES BH, BN, AND BO IN SUNSPOTS AND THE SOLAR ABUNDANCE OF BORON. Engvold, O. (Univ. of Oslo, Blindern, Norway). Solar Phys.; 11: 183-97 (Feb 1970).

Absorption-band spectra of BH and BO were searched for and not found in spectra of sunspots. Electronic oscillator strengths are available only for the $A^1\Pi - X^1\Sigma^+$ system of the BH molecule. The absence of the (0,0) band of BH at 4332 Å reflects a solar abundance of boron $\log A_B < 2.5$. The band spectra of BN are several orders of magnitude weaker in sunspots than those of BH and BO. (auth)

23669 CAN THE ION H_3^+ ACCOUNT FOR MISSING OPACITY IN THE SOLAR ULTRAVIOLET. Linsky, Jeffrey L. (Univ. of Colorado, Boulder). Solar Phys.; 11: 198-207(Feb 1970).

Limb darkening and specific intensity data imply more continuous opacity in the solar photosphere between 2000 Å and 3500 Å than has been predicted theoretically. The temperature dependence and wavelength dependence of this missing opacity are in qualitative agreement with those deduced for the ion H_3^+, but it is unlikely that H_3^+ is sufficiently abundant to account for this opacity. (auth)

23670 SOLAR XUV LIMB BRIGHTENING OBSERVATIONS. II. LINES FORMED IN THE CHROMOSPHERIC–CORONAL TRANSITION REGION. Withbroe, George L. (Harvard Coll. Observatory, Cambridge, Mass.). Solar Phys.; 11: 208-21(Feb 1970).

Limb brightening of xuv lines of the ions C III, N III, N IV, O IV, O V, and Si IV is compared with that predicted by a modified version of a coronal model developed by Dupree and Goldberg. Systematic differences between the predicted and observed limb brightening are found. These differences can be eliminated by introducing into the model the effects of spicules that extend up into the chromospheric–coronal transition region. The spicules are assumed to be opaque to radiation between 500 and 900 Å because of absorption in the hydrogen Lyman continuum. (auth)

23671 LONG TERM OBSERVATIONS OF THE Hα CHROMOSPHERIC NETWORK. Janssens, T. J. (San Fernando Observatory, Calif.). Solar Phys.; 11: 222-42(Feb 1970).

Frequent filtergrams of the quiet Sun at Hα + 0.65 Å were taken from above the Arctic Circle during a period of 62 hr. Features observed in individual filtergrams or movies are described with the dynamic changes they undergo. Thirty filtergrams taken at 2-hr intervals are presented and the development of a typical supergranule is shown in some detail. A study of supergranules shows that they lose their identity in about 21 hr on the average. (auth)

23672 THE EXCITATION OF THE FORBIDDEN CORONAL LINES. II. [CaXV] λλ 5694 and 5446. Chevalier, R. A.; Lambert, D. L. (Carnegie Institution of Washington, D. C.). Solar Phys.; 11: 243-57(Feb 1970).

The excitation of the $2s^22p^3$ ground configuration of CaXV is calculated for coronal densities and temperatures. The calculations include electron and proton excitation of the forbidden transitions and electron excitation via the first excited ($2s2p^3$) configuration. It is shown that measurements of the line intensity ratio I(λ5694)/I(λ5446) are in good agreement with the predictions. The line of continuum observations for limb flares and coronal condensations are discussed. It is suggested that the calcium abundance in condensations is enhanced owing to diffusion processes. (auth)

23673 SOME INTERACTION EFFECTS OF SOLAR ACTIVE CENTERS. Martres, M.-J. (Observatoire de Paris, Meudon, France). Solar Phys.; 11: 258-62(Feb 1970).

Following the study of anomalies in spot groups correlated to the existence of an older active center (A.C.) in the same region, the evolution of 50 A.C. of simple magnetic configuration β or α was compared. The growth and the proper motion of their spots are associated with the absence or the presence of an A.C. in the vicinity. It was found that a group situated to the west of an older one evolves to the type β_f and shows an eastward motion of the following spot greater than in the case of an isolated group. Symmetrically, the evolution of β_p of a group situated to the east of the original formation is associated with a westward motion of the leading spot greater than in the case of an undisturbed group. The difference between those displacements and the average ones corresponding to an isolated A.C. is the same in both cases and is equal to about 1.5° in three days for the groups of the sample chosen. (auth)

23674 SOLAR-FLARE VIDEOMETER. Tallant, Paul E. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys.; 11: 263-75(Feb 1970).

A new instrument, called a videometer, has been developed to measure solar flare area, peak intensity, and integrated intensity in real time. The videometer uses a closed circuit television system to convert an optical Hα image into electrical signals for measurement. Observations of two Class I flares with the videometer are discussed. (auth)

23675 IDENTIFICATION OF THE HARD X-RAY PULSE IN THE FLARE OF SEPTEMBER 11–12, 1968. Vorpahl, J. (Univ. of California, Berkeley); Zirin, H. Solar Phys.; 11: 285-90 (Feb 1970).

A hard x-ray pulse in the September 11-12, 1968 flare is identified with the formation of a brilliant kernel. Each stage in the x-ray event corresponds to a definite phase in flare development. (auth)

23676 EXAMPLE OF RADIO AND OPTICAL HOMOLOGOUS FLARES. White III, K. P. (Univ. of California, Los Angeles); Janssens, T. J. Solar Phys.; 11: 291-8(Feb 1970).

Fokker (1967) raised the question of whether the optical and radio homologies of flares are correlated. Two 2b flares occurring nearly 54 h apart (July 9 and 12, 1968) were observed at 29 wavelengths from Hα + 4.00 Å to Hα – 4.26 Å and at 10-cm radio. Adjacent pictures were spaced 0.295 Å and 2 sec apart. The time resolution of the radio traces was about 10 sec. Detailed comparison of the pictures showed near-perfect similarities in the two events. These similarities included flare shape, filament agitation, rising arch formation and surges with line-of-sight velocities nearly 200 km/sec observed. Comparison of the microwave radio flux traces showed detailed similarities in the shapes and "simultaneity" of at least eight features. (auth)

23677 DESCRIPTION OF MASS MOTIONS AND BRIGHTENINGS IN A CLASS 2b FLARE, AUGUST 8, 1968. Janssens, T. J. (San Fernando Observatory, El Segundo, Calif.); White III, K. P. Solar Phys.; 11: 299-309(Feb 1970).

Filtergrams spanning Hα ± 4.1 Å, supplemented with observations at 2.8 and 3 GHz, are used variously to describe the onset, dormancy, and flash phase of this 2b flare. Among the phenomena observed are 17- and 23-sec periodic pulsations in the microwave data early in the flare and formation of perpendicular, overlapping threads of red-shifted and blue-shifted material late in the flare. (auth)

23678 EXPANDING ARCH STRUCTURE OF A SOLAR RADIO OUTBURST. Kai, K. (CSIRO, Sydney). Solar Phys.; 11: 310-18(Feb 1970).

A flare-associated complex outburst was observed on October 23-24, 1968 with the 80 MHz Culgoora radioheliograph. Two harmonic type II bursts were followed by two successive extended sources with arch structure which appeared further beyond the optical limb than the preceding sources. The second arch showed a remarkable expansion with a projected velocity of 1200 km/sec. At its maximum the arch extended to a height of $2R_\odot$. The height–time plots derived from both the radioheliograph and spectrum observations suggest that two shock waves of different propagation velocities were initiated at the flash phase of the flare: the faster one was responsible for the first type II burst and the first radio-emitting arch; the slower one for the second type II burst and the second arch whose expansion advanced with the shock front. (auth)

23679 COMMENTS ON A PAPER BY D. MEISEL ENTITLED 'IDENTIFICATION OF A SOLAR X-RAY SOURCE USING D-LAYER IONIZATION BEHAVIOR DURING AN ECLIPSE'. Aikin, A. C.; Underwood, J. H. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 11: 334-42(Feb 1970).

It is pointed out that Meisel's paper (Meisel, 1968) contains serious errors which invalidate his principal conclusions. Some of these errors are enumerated. A reply by Meisel is included. (W.D.M.)

23680 SOME DEVELOPMENTS OF THE MAGNETIC BEAM ABSORPTION FILTER. Cimino, M.; Cacciani, A.; Fofi, M. (Osservatorio Astronomico, Rome). Solar Phys.; 11: 319-33 (Feb 1970).

Some experimental arrangements are shown which utilize the magnetic filter described by Cimino et al. (1968). For a single cell an elementary theory is elaborated for the following cases: (i) absorption by an atomic beam in a uniform magnetic field (i.e., pure damping profile); (ii) atomic beam in a nonuniform magnetic field; (iii) vapors in a uniform magnetic field (i.e., gaussian distribution); and (iv) vapors in a nonuniform magnetic field. (auth)

23681 MEASUREMENTS OF THE SOLAR X-RAY FLUX IN SELECTED EMISSION LINES. Argo, H. V.; Bergey, J. A.; Evans, W. D. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 160: 283-92(Apr 1970).

Curved-crystal Bragg spectrometers were flown in low-altitude sounding rockets with two-axis attitude control to measure absolute fluxes from the whole solar disk in selected prominent emission lines in the region 13 to 34 Å. Typical values are: C VI La at 33.74 Å, from 2×10^{-2} to 6×10^{-2} erg cm^{-2} sec^{-1} at 1 A.U.; O VIII La at 18.97 Å, from 0.5×10^{-2} to 3×10^{-2} erg cm^{-2} sec^{-1}; continuum at 18.2 Å, $< 5 \times 10^{-3}$ erg cm^{-2} sec^{-1} $Å^{-1}$. These measurements were made under a variety of solar conditions (but nonflare) and in general indicate a significantly higher flux, integrated over the disk, than has been reported. (auth)

23682 DYNAMIC SPECTRA OF TYPE III SOLAR BURSTS FROM 4 TO 2 MHz OBSERVED BY OGO-III. Haddock, F. T.; Graedel, T. E. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 160: 293-300(Apr 1970).

The characteristics of Type III solar bursts from 4 to 2 MHz, as determined from 218 bursts detected by an antenna/radiometer package aboard OGO-III, are presented. These data represent the first large sample of information on low-frequency solar bursts and the first dynamic spectra with high time resolution obtained below ionospheric cutoff frequencies. The peak flux densities at 3.5 MHz average approximately 1×10^{-16} W m^{-2} Hz^{-1}, and have a

range of (1 to 110) × 10^{-17} W m^{-2} Hz^{-1}. The average drift rate over the (4 to 2)-MHz band is 0.095 ± 0.010 (m.e.) MHz sec^{-1}. At 3.5 MHz the e-folding duration averages 23.3 ± 1.4 seconds and implies a coronal-electron temperature of 2.6 ± 0.1 × 10^5 °K at 5.5 $R_\odot$ if collision damping is assumed. Type V continuum followed the Type III bursts in 1.8% of the cases studied. No Type II or Type IV events were observed at these frequencies; evidence for Type I radiation is inconclusive. (auth)

23683 THE ASSOCIATION OF SOLAR OPTICAL FLARES WITH TYPE III SOLAR BURSTS FROM 4 TO 2 MHz OBSERVED BY OGO-III. Graedel, T. E. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 160: 301-7 (Apr 1970).

Type III solar radio bursts from 4 to 2 MHz observed by OGO-III have been associated with optical flares and, hence, with solar plage regions. A radio burst was considered to be flare associated if it occurred within 10 min of the reported flare maximum. With this criterion, 70% of the radio bursts were found to be associated with flares or subflares. On the average, the burst preceded the reported flare maximum by 1.45 min. The plage regions associated with the greatest number of radio bursts were, in general, those which were largest, brightest, and of greatest sunspot area and field strength. Since radio bursts are thought to originate in coronal streamers, it is inferred that these plage regions are associated with coronal streamers of radial length 5$R_\odot$ or greater. The data suggest that a major change in filament or sunspot structure in a large plage region can temporarily create or enhance the conditions necessary for the propagation of electron streams to large radial distances and that well-established streamers maintain their integrity and magnetic-field structure for as long as two solar rotations. (auth)

23684 IRON LINE EMISSION AT 1.9 A DURING SOLAR FLARES. Culhane, J. L.; Phillips, K. J. H. (Univ. College, London). Astrophys. J.; 160: 309-13 (Apr 1970).

Solar x-ray spectra were obtained with a proportional-counter spectrometer on board the Orbiting Solar Observatory 4. Observations of an iron line at around 1.9 Å are presented that suggest that the line is nonthermally excited. (auth)

23685 MAGNETIC FIELDS IN QUIESCENT SOLAR PROMINENCES. II. PHOTOSPHERIC SOURCES. Rust, David M. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 315-24 (Apr 1970).

Magnetograph observations of the photospheric magnetic fields 100,000 km on either side of quiescent filaments have been made by using the 5250 Å line of iron. Resolution was 5″. The region ("neutral band") below stable filaments is free of radial fields more intense than 5 gauss. Filament structure is extremely sensitive to fields near the neutral band. Filaments detour around local field concentrations or thin down enough to squeeze by. Occasionally, a filament will break up and reform about 30″ away from intruding fields. Comparisons of the magnetic flux through filaments with that measured on either side of the neutral band show that the magnetograph underestimates the flux outside active regions by a factor of 4. A comparison of observations with the Kippenhahn and Schlüter magnetohydrostatic model of prominences tends to confirm the correctness of the model. Sections of observed filaments are unstable and appear to be subject to disappearance when a nascent bipolar feature appears in the neutral band. (auth)

23686 FREE-FREE ABSORPTION COEFFICIENT OF THE NEGATIVE HYDROGEN ION. Stilley, J. L.; Callaway, J. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 160: 245-60 (Apr 1970).

The dipole adiabatic-exchange wave functions of polarized-orbital theory were employed to obtain the S ⟷ P and P ⟷ D contributions to the free-free absorption coefficient of H^- in the dipole-length and dipole-velocity formulations. The length and velocity results were found to be in good agreement, 3% or less at the longer wavelengths where free-free absorption dominates bound-free absorption. These results were found to be in good agreement with other recent calculations and with solar observations. The effects of atomic distortion were found to be small at longer wavelengths (1% for length formulation and 6% for velocity formulation), a result which makes their inclusion relatively unimportant for astrophysical applications. Asymptotic matrix elements, which are convergent over all space, reproduce the full results to within 10%. (auth)

23687 THE MAPPING OF THE SUN AT 3.5 MM. Buhl, David; Tlamicha, Antonin (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 5: 102-12 (Mar 1970).

Maps of the Sun at a wavelength of 3.5 mm having a resolution of 1.2 were made from May 15 to June 1, 1968, using the NRAO 36-foot telescope. Comparisons made with Hα photographs and magnetograms indicate that the intense peaks in the radio emission coincide with bright plage regions and depressions with dark filaments. The radio-emission peaks have temperatures as high as 700°K, while the depressions are 100 to 200°K. Some effect of optical depth is noted in the radio maps for sources close to the limb. Distinct pole darkening amounting to 200 to 300°K is evident in the outer contours of the maps. (auth)

23688 SOLAR-X-RAY OBSERVATION OF FORBIDDEN LINES IN THE HELIUM ISOELECTRONIC SEQUENCE. Walker, A. B. C. Jr.; Rugge, H. R. (Aerospace Corp., El Segundo, Calif.). Astron. Astrophys.; 5: 4-11 (Mar 1970).

The $1s^2\ {}^1S_0$–$1s\ 2p^1P_1$ resonance and the $1s^2\ {}^1S_0$–$1s\ 2p^3P_1$ intercombination lines in the helium-like ions of carbon, oxygen, neon, and magnesium observed in the solar corona are accompanied by strong, longer-wavelength satellites. Gabriel and Jordan have recently identified these satellites as due to single photon decay of the $1s\ 2s\ {}^3S_1$ level, and have pointed out that the intensity ratio of the $^3P_1$ and $^3S_1$ lines is a sensitive function of electron density at typical coronal densities. These three lines in oxygen, neon, aluminum, silicon, and sulphur were observed with a scanning Bragg crystal spectrometer which was orbited on the satellite OV1-17 (1969-025A), launched on March 18, 1969. The relative intensities of each of the three lines are reported and the coronal densities which they predict are discussed. Weaker satellite lines were also observed, which may be due to transitions in lithium like ions in neon, silicon, and sulfur. (auth)

Galaxies

23689 REDSHIFTS OF COMPANION GALAXIES. Arp, H. (California Inst. of Tech., Pasadena). Nature (London); 225: 1033-5 (14 Mar 1970).

It is usually assumed that QRSs and compact radio galaxies are ejected from galaxies, and that galaxy redshifts are due only to Doppler velocity shifts. Objects that differ greatly in redshift are always presumed to be at different distances, so as not to violate the velocity-distance relation. The only way in which such an assumption could be shown to be incorrect would be to demonstrate that objects of greatly different redshifts cluster together. Observational evidence on QSRs and radio compact galaxies simply indicates that they do cluster around lower-redshift galaxies and tend to be aligned and paired across these galaxies. Another kind of test on the nature of the redshifts is suggested, involving an investigation of smaller "companions" around galaxies, which are accepted as belonging to the central galaxy and essentially at the same distance as the larger galaxy. If the intrinsic redshift changes from high to low values as the objects ejected from galaxies evolve towards brighter and less-compact companions, it would be expected that even the normally accepted companions would have at least some small residual excess redshift; and even if there is no evolution involved and objects of various redshifts are ejected, the companion galaxies would still be expected to have somewhat higher redshifts, on the average, than the parent galaxy. A list is given of all galaxies having companions that are unquestionably accepted as belonging to the larger galaxies. Also listed are six spiral galaxies with companions at the ends of their arms. Overall, the redshift of the companion galaxy is higher than that of the main galaxy in 16 out of 19 cases. If interpretation of the entire redshift of each companion were continued to be interpreted as a velocity shift, the absurd situation would arise where the companions were systematically receding from the main galaxy along the line of sight to that main galaxy. Possible reasons are given as to why the three negative redshifts are questionable. Although clusters of galaxies represent a somewhat different situation to dominant galaxies with companions, an investigation of some of the fainter clusters affords further evidence for fainter galaxies in the clusters bonding to have higher redshifts. The slope of the excess redshift-magnitude relationship appears steeper for clusters than for the dominant-galaxy-with-companions case. This might be related to the possibility of larger galaxies fragmenting, which would make each original low redshift fragment fainter, and thus steepen the relationship; it might also be related to the much higher dispersion of redshifts encountered in the more distant clusters, much higher redshift objects being included as cluster members, making the slope much steeper. It is concluded that the systematically higher redshifts for the companion galaxies support the hypothesis that compact intrinsically higher redshift objects are ejected from nearby galaxies, and contradict the current assumption that galaxy redshifts are due only to Doppler velocities. It observationally contradicts the principle which has been invoked to reject the previous observational evidence for association of high and low redshift objects. (UK)

23690 THE EFFECT OF TURBULENT FLUCTUATIONS IN THE INTERSTELLAR GAS AND MAGNETIC FIELD ON FARADAY ROTATION. Lerche, I. (Univ. of Chicago). Astrophys. Space Sci.; 6: 481-91(Mar 1970).

The effect of fluctuations in both the interstellar electron number density and galactic magnetic field on the propagation of high-frequency radio waves is discussed in terms of the frequency-dependent Faraday rotation. It is shown that, when the fluctuations are representative of large-scale disturbances (1 to 10^2 pc) in the interstellar medium, then the observed Faraday rotation is not a measure of the line-of-sight integral of the product of the magnetic field with the electron number density. Since evidence has been presented elsewhere for believing that such large-scale disturbances do exist in the Galaxy, some care must be exercised in the physical interpretation of Faraday rotation measurements. (auth)

23691 INTENSITY OF THE INFRARED RADIATION FROM INTERSTELLAR GRAINS IN THE SOLAR NEIGHBORHOOD. Krishna Swamy, K. S. (Rice Univ., Houston). Astrophys. Space Sci.; 6: 474-80(Mar 1970).

The expected intensity distribution of the infrared radiation in the solar neighborhood from the grain models of dirty ice, graphite, and graphite core–dirty ice mantle was calculated. It is found that the expected intensity from grain models at 100 μ agrees reasonably well with the observations of Hoffmann and Frederick. (Astrophys J. Lett., 155: L9(1969)). (auth)

23692 THE MAGNETIC-FIELD STRUCTURE OF THE MAGELLANIC CLOUDS. Mathewson, D. S.; Ford, V. L. (Australian National Univ., Canberra). Astrophys. J.; 160: L43-6 (Apr 1970).

Observations of the polarization of stars in the Magellanic Clouds show the existence of a large-scale, regular magnetic field which is probably associated with the Magellanic System. Strong polarization occurs in the regions rich in Population I components where the magnetic field is twisted with respect to the surrounding magnetic field of the Magellanic System. 30 Doradus has the strongest polarization, and the E-vectors show a remarkable focusing of the magnetic lines of force on this giant emission nebula. (auth)

23693 CLASSIFICATION OF THE CORES OF SOME ELLIPTICAL GALAXIES. Parsamyan, E. S. (Byurakan Astrophysical Observatory, Moscow). Astrophysics (Engl. Transl.); 4: 49-51 (Spring 1968).

Translated from Astrofizika; 4: 150-2(1968).

The classification is based on the appearance of the core region and the photometry of bright stellar cores. A number of elliptical galaxies in the general field and in the Virgo cluster were chosen for study. Lists of the galaxies and the classification of their cores are given. (W.D.M.)

23694 CENTRAL CONDENSATIONS IN Sb GALAXIES. Saakyan, K. A. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 17-25(Spring 1968).

Translated from Astrofizika; 4: 41-57(1968).

The results of a classification of central condensations in 82 Sb galaxies are reported. About 38% of the observed galaxies have stellar cores. Histograms for the distribution of the central parts of galaxies based on the five-unit classification of the Byurakan Observatory are given, together with photometric data for classes 5, 4, and 3. The results are compared with those reported by other authors. (auth)

23695 DETAILED PHOTOGRAPHIC POLARIMETRY OF THE M 82 GALAXY. Gagen-Torn, V. A. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 26-31(Spring 1968).

Translated from Astrofizika; 4: 93-103(1968).

The results of photographic polarimetry of the M82 galaxy are reported. It is noted that the observed polarization cannot be explained in terms of synchrotron radiation but is readily explained by the scattering of light from bright regions of the galaxy by dust in the halo. It is shown that scattering by free electrons plays an appreciable part in this process. (auth)

23696 SINGLE RADIO SOURCES IN THE VICINITY OF GALAXIES. Tovmasyan, G. M. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 32-8 (Spring 1968).

Translated from Astrofizika; 4: 117-28(1968).

Evidence was obtained for the existence of single radio sources in the vicinity of normal spiral galaxies that are physically associated with them. The mean distance of the radio sources from the corresponding galaxies is about 30 to 40 kpc. The spectra of some of these radio satellites show a characteristic change of slope in the decimeter wavelength range. No similar enhancement in the density of radio sources was observed near more distant clusters of galaxies. (auth)

23697 GALAXIES AND QUASARS: PUZZLING OBSERVATIONS AND BIZARRE THEORIES. Holcomb, Robert W. Science; 167: 1601-3(20 Mar 1970).

Infrared observations of galaxies and quasars are discussed in terms of energy and instruments. The new theory of Low, Kleinmann, and Aumann featuring the irtrons is discussed in some detail. Other theories are briefly mentioned. (W.D.M.)

23698 RADIATION FROM PLASMA SYSTEMS MOVING WITH RELATIVISTIC VELOCITIES. Monaghan, J. J. (Monash Univ., Victoria, Australia). Mon. Notic. Roy. Astron. Soc.; 147: 207-13(1970).

The radiation produced when a plasma system, with a centre of mass velocity close to the velocity of light, passes through a spatially varying, but static magnetic field, is studied. The analysis is performed in the rest frame of the plasma system where the electromagnetic field approximates closely that of a plane wave. In this reference frame the radiation may be viewed as a reflection process. The spectrum is determined for both large and small systems. Applications to astrophysical phenomena are discussed briefly. (auth)

23699 A NECESSARY AND SUFFICIENT CONDITION FOR THE COLLISIONLESS STABILITY OF A STELLAR SYSTEM IN THE POST-NEWTONIAN APPROXIMATION. Sudbury, A. W. (Monash Univ., Victoria, Australia). Mon. Notic. Roy. Astron. Soc.; 147: 187-99(1970).

Using an extension of a method of Antonov (1960 and 1962), a necessary and sufficient condition for the collisionless stability of stellar systems whose distribution function depends only on the energy of each star is given for the post-Newtonian approximation. It is shown that in this approximation, systems that are spherically symmetric, with $F_E < 0$ in the steady state, are stable against nonradial perturbations. (auth)

23700 SPECTROSCOPIC STUDY OF THE DOUBLE GALAXY NGC 3395-3396. D'Odorico, Sandro (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 3-9(Apr 1970).

Spectra of NGC 3395 and NGC 3396, a pair of interacting galaxies, show emission lines of H I, He I, [O II], [O III], [N II], and [S II]. In both galaxies the intensity of Hα is greater than that of [N II] λ6583, as in most Sc, irregular, and Seyfert galaxies. The intensity ratios Hα/Hβ = 5.1 in NGC 3395 and Hα/Hβ = 7.5 in NGC 3396 suggest that large amounts of dust may be present in the nuclei of the two galaxies. Within 1.5 kpc of the nucleus, NGC 3395 rotates as a solid body and has an approximate mass of 1.2×10^9 $M_\odot$. Velocities in NGC 3396 show no appreciable rotation. The general velocity field is consistent with the hypothesis that NGC 3396 rotates around NGC 3395. (auth)

23701 ON THE ROTATION CURVES OF Sb AND Sc GALAXIES. Saslaw, William C. (Univ. of California, Berkeley). Astrophys. J.; 160: 11-16(Apr 1970).

The radii, R, and constant angular velocities, ω, of the central regions are correlated in Sb and Sc galaxies. These correlations may differ for the two classes of galaxies. In Sb galaxies, R and ω may also be correlated with the mass of the galaxy. The significance and uncertainties in these results are discussed briefly. (auth)

23702 ELECTRON-SCATTERING LINE PROFILES IN NUCLEI OF SEYFERT GALAXIES. Weymann, Ray J. (Univ. of Arizona, Tucson). Astrophys. J.; 160: 31-41(Apr 1970).

Line profiles for emission lines broadened by electron scattering are calculated and compared with Anderson's composite profile of the Balmer lines in the Seyfert galaxy NGC 5548. The computed profile for a model in which $T_e = 20000°K$, in which the electron-scattering optical depth is less than 1, and in which there is significant opacity in the Balmer lines, yields profiles that are much too narrow. In addition, for the parameters deduced by Oke and Sargent for the forbidden-line emitting regions of NGC 4151, the optical depth in the Balmer lines would be very much less than 1. Fairly good agreement is obtained for an electron temperature of 20,000°K and a value of 10 for the optical thickness to electron scattering. Under such conditions, to produce such a profile having the same total luminosity in Hβ as that observed in NGC 4151, it is necessary to postulate a small dense region having an electron density of 2.5×10^9 cm^{-3} and a dimension of only 0.005 pc. Forbidden lines would be suppressed in this region. The absorption-line components in the Balmer lines discovered by Anderson and Kraft are interpreted as evidence for such a dense component. The effects of radiation pressure on material in such a dense region surrounding a small intense source of radiation are significant and might give rise to the observed radial outflow of matter. (auth)

23703 THE SKY NEAR THE BRIGHTEST X-RAY SOURCE IN SCORPIUS. II. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J.; 160: 193-7(Apr 1970).

The luminous nebulae within 18° of Sco X-1 were observed with an Hβ photometer. Twenty out of fifty-one of them definitely show Hβ in emission. Nearly all appear to be photoionized by hot stars in the Sco–Cen association rather than by Sco X-1, although Sco X-1 is also a probable member of the association and is a source of high-energy photons. Specific stars are proposed for association with the nebulae. (auth)

23704 QUESTION OF INTERSTELLAR SILICATE ABSORPTION. Donn, B.; Krishna Swamy, K. S.; Hunter, C. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 160: 353-5(Apr 1970).

The observations of the absorption feature in the infrared spectrum by Knacke, Gaustad, Gillett, and Stein are discussed; and doubts concerning their identifying silicate minerals in interstellar grains are raised. (auth)

23705 OBSERVATIONS OF THE SPATIAL STRUCTURE OF INTERSTELLAR HYDROGEN. II. OPTICAL DETERMINATION OF DISTANCES IN A SMALL REGION. Ames, Susan; Heiles, Carl (Univ. of California, Berkeley). Astrophys. J.; 160: 59-64(Apr 1970).

A configuration of interstellar neutral hydrogen, suggested earlier to be in the form of sheets, is examined in more detail, by using both the 21-cm radio data and optical spectra of stars in that region of the sky showing interstellar absorption lines. It is concluded that the sheets are fairly thin, with a thickness of the order of less than 10 pc, and that they are approaching each other and are in fact colliding supersonically in one region. (auth)

23706 THE DISTRIBUTION OF HYDROGEN IN A REGION IN TAURUS. II. HIGH-RESOLUTION OBSERVATIONS. Garzoli, Silvia L.; Varsavsky, Carlos M. (Instituto Argentino de Radioastronomia, Buenos Aires). Astrophys. J.; 160: 75-82(Apr 1970).

Over 10,000 profiles of the 21-cm line of atomic hydrogen were measured in a region of 150 square degrees centered at $\alpha = 4h30m$, $\delta = 27°$. The variation of the number density of hydrogen atoms was compared with measurements of optical absorption made by McCuskey. As a result a decrease of hydrogen with obscuration of 1.6×10^{20} atoms cm^{-2} mag^{-1} was obtained. In a small area of 8 square degrees observed optically by Bok an increase of hydrogen of 0.4×10^{20} atoms cm^{-2} mag^{-1} was observed. In either case one can say that the density of atomic hydrogen is not directly proportional to the density of grains, an observation suggesting that in dense clouds most of the hydrogen becomes molecular. The observations were taken with the 300-foot telescope of the National Radio Astronomy Observatory. (auth)

23707 THE RATIO OF ATOMIC HYDROGEN TO DUST IN THE DIRECTION OF THE OMEGA NEBULA. Quiroga, Ramon J.; Varsavsky, Carlos M. (Instituto Argentino de Radioastronomia, Buenos Aires). Astrophys. J.; 160: 83-8(Apr 1970).

The 21-cm line of atomic hydrogen was observed in absorption against the continuum background of the thermal source known as the Omega Nebula (M17, NGC 6618). The absorption profile was observed in directions where there is relatively little dust and also in the direction of a dense dust cloud. A decrease in the optical depth of the 21-cm line in the latter direction indicated that in the presence of dust part of the hydrogen may become molecular. Because of the size of the beam it is not possible to make a precise quantitative determination of the decrease in the number of hydrogen atoms. The observations were made with the 30-m dish of the I.A.R.–Carnegie Radio Astronomy Station in Argentina. (auth)

23708 ON THE DENSITY-WAVE THEORY OF GALACTIC SPIRALS. I. SPIRAL STRUCTURE AS A NORMAL MODEL OF OSCILLATION. Shu, Frank H. (State Univ. of New York, Stony Brook). Astrophys. J.; 160: 89-97(Apr 1970).

An exact formulation of the linearized problem, including appropriate boundary conditions, is developed to explore whether extensive galactic density waves of spiral form are permissible normal modes of oscillation for a stellar disk. An "anti-spiral theorem," of the type reported previously by Lynden-Bell and Ostriker for neutral modes in a gaseous disk, holds here with limited validity—namely, whenever the effects of stellar resonances can be ignored. (auth)

23709 ON THE DENSITY-WAVE THEORY OF GALACTIC SPIRALS. II. THE PROPAGATION OF THE DENSITY OF WAVE ACTION. Shu, Frank H. (State Univ. of New York, Stony Brook). Astrophys. J.; 160: 99-112(Apr 1970).

The properties of galactic density waves are studied in the WKBJ approximation. In the lowest order of approximation, the dispersion relation reported by Lin and Shu in an earlier communication is reproduced. In the next order, it is demonstrated explicitly that the density of "wave action" is transported with the group velocity derived by Toomre. Some general implications are drawn for mechanisms proposed for the origin of spiral structure. (auth)

23710 RESONANCE EFFECTS IN SPIRAL GALAXIES. Contopoulos, G. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 160: 113-33(Apr 1970).

The usual form of the distribution function in a spiral galaxy, $f = f_0 + f_1 + \ldots$, where f_0 is a function of the energy and angular momentum of the axisymmetric configuration, is not applicable, in general, near resonances. A resonance occurs whenever the ratio of the frequency of the radial oscillation to that of the rotational motion around the center of the galaxy (in a frame of reference rotating together with the spiral pattern) is rational. Near the Lindblad resonances, where this ratio is equal to 2, f_1 has a secular term or a small divisor term that makes it large in comparison with f_0. In order to avoid secular terms in resonant cases, a new integral of the axisymmetric case is used, namely, the sine or cosine of the initial phase angle, which is then isolating. Thus, a new form of f_0 is found that has a quadruple symmetry in the phase angle θ' in the rotating frame. Various resonances expected to occur in the Galaxy are considered. The forms of the orbits and invariant curves near the inner Lindblad resonance are studied; and two stable resonant periodic orbits and tube orbits around them are found. A comparison between the theoretical results and the numerical calculations is made. Finally, it is seen how the stars respond to a growing spiral wave. As the wave is established, the orbits near resonance change from their original epicyclic form to a resonant form near one or the other of the two resonant periodic orbits. The resulting density distribution has roughly a quadruple symmetry. (auth)

23711 STELLAR HYDRODYNAMIC EQUATIONS FOR A THIN DISK GALAXY. Hunter, C. (Massachusetts Inst. of Tech., Cambridge). Stud. Appl. Math.; 49: 59-68(Mar 1970).

Assuming that the motions of stars depart only slightly from circular, finite closed systems, stellar hydrodynamic equations are obtained for a disk galaxy by taking moments of the collisionless Boltzmann equation. The usual closure problem is avoided in that explicit expressions are obtained for the highest moments arising. (auth)

23712 AN EXPERIMENTAL STUDY OF THE DUST OF IRON, CARBON, SILICON CARBIDE, AND SILICA. Lefevre, J. (Observatoire, Nice). Astron. Astrophys.; 5: 37-44(Mar 1970).

Grains of iron, carbon, silicon carbide, and silica were produced by striking an electric arc in argon. Their shapes, sizes, and grouping were studied with an electron microscope. The size of the grains varied from 100 to 2000 Å. They were spherical only for silica and in every case were associated in chain-like structures that can be explained by van der Waals forces for the nonmetallic particles. The optical absorption of the clouds of dust was measured at wavelengths between 3600 and 7000 Å and the results compared with Mie's theory for spheres or infinite cylinders of the same size. A good agreement was obtained only for silica. Silicon carbide presents three broad features in absorption centered at 4400 to 4300 Å, 5800 Å, and 6600 to 6700 Å. (auth)

23713 GRAVITATIONAL INSTABILITY: AN APPROXIMATE THEORY FOR LARGE DENSITY PERTURBATIONS. Zeldovich, Ya. B. (Inst. of Applied Mathematics, Moscow). Astron. Astrophys.; 5: 84-9(Mar 1970).

An approximate solution is given for the problem of the growth of perturbations during the expansion of matter without pressure. The solution is qualitatively correct even when the perturbations are not small. Infinite density is first obtained on disc-like surfaces by unilateral compression. The following layers are compressed first adiabatically and then by a shock wave. Physical conditions in the compressed matter are analyzed. (auth)

23714 DYNAMICAL MIXING OF ORBITS IN THE SPHERICAL WATER-BAG MODEL. Bouvier, P.; Janin, G. (Geneva Observatory). Astron. Astrophys.; 5: 127-34(Mar 1970).

The evolution of a self-gravitating spherical system during its preliminary stage of orbital mixing is considered. Initial conditions are chosen according to the so-called water-bag model; numerical integration of the equations of motion discloses the detailed dynamical evolution of the system. After some time, a steady state is attained, characterized by a certain configuration of the representative points in phase space. It appears useful to compare that state with the virtual steady state obtained merely by expressing the conservation of the fine-grained density; the latter state is

linked with a polytropic spatial configuration, which allows one to define, for different values of the initial virial ratio, a radius for the central core of the system and a natural unit of time for the orbital mixing phase. (auth)

Cosmology

Refer also to abstracts 24196 and 24304.

23715 POSSIBILITY OF A LARGE EVOLUTIONARY CORRECTION TO THE MAGNITUDE–REDSHIFT RELATION. Tinsley, Beatrice M. (Univ. of Texas, Dallas). Astrophys. Space Sci.; 6: 344-51(Mar 1970).

Galactic evolution may be rapid enough to reconcile the observed magnitude–redshift relation with cosmological models of acceptably great age and low density, in spite of recent evidence to the contrary. Previous treatments of this subject have suffered from use of wrong quantities as the evolutionary correction, and from lack of generality in galactic models. A range of giant elliptical galaxies can be synthesized which are compatible with the available photometry, including Oke and Sandage's (1968) observations of a slow rate of change of color B–V. One such model galaxy is discussed which evolves sufficiently rapidly at short wavelengths to provide an evolutionary correction of several tenths of a magnitude at redshift 0.46. (auth)

23716 COSMOLOGICAL BASIS FOR HYPERBOLIC VELOCITY SPACE. Prokhovnik, S. J. (Univ. of New South Wales, Sydney). Proc. Cambridge Phil. Soc.; 67: 391-5(1970).

It is shown that a cosmological model of light propagation associated with a uniformly expanding Universe provides a physical significance to the hyperbolic velocity space by which this model can be described. Some implications of this result are discussed. (auth) (UK)

23717 GRAVITHERMODYNAMICS. III. PHENOMENOLOGICAL NON-EQUILIBRIUM THEORY AND FINITE-TIME FLUCTUATIONS. Saslaw, William C. (Univ. of California, Berkeley). Mon. Notic. Roy. Astron. Soc.; 147: 253-78(1970).

A self-gravitating medium which may be far from equilibrium is investigated. A unified theory, based on propagators for macroscopic variables, describes both spatial and temporal fluctuations, and the coupling between them. As gravitational interactions become important, fluctuations grow rapidly and become highly correlated with one another. Then an unstable, nonanalytic phase transition develops. Rapid expansion does not prevent macrofluctuations; contraction can enhance them. The dominant-length scale contains enough mass to enable the gravitational energy to balance the total kinetic and expansion energies. The time scale is not given directly by the theory but because cooperative effects dominate, it is probably about the time needed for a particle moving with typical random velocity to cross the dominant length scale. This supports the view that nonhydrodynamic fluctuations may develop in most cosmologies after matter and radiation decouple. Their amplitude is sufficient to start the process of condensation which leads, ultimately, to the formation of galaxies and clusters of galaxies. (auth) (UK)

23718 GENERATION OF MAGNETIC FIELDS IN THE RADIATION ERA. Harrison, E. R. (Univ. of Massachusetts, Amherst). Mon. Notic. Roy. Astron. Soc.; 147: 279-86(1970).

It is shown that magnetic fields are generated during the radiation era of the early Universe in regions that have rotation. These fields are weak compared with the present intensity of the galactic magnetic field and, therefore, must be amplified as the Galaxy forms and evolves. (auth) (UK)

23719 EVOLUTION OF RADIO SOURCES AT LARGE REDSHIFTS. Doroshkevich, A. G. (Inst. of Applied Mathematics, Moscow); Longair, M. S.; Zeldovich, Ya. B. Mon. Notic. Roy. Astron. Soc.; 147: 139-48(1970).

Evolutionary cosmological models in which the radio source population can extend to large redshifts are discussed. Models incorporating exponential and power-law forms of evolution of the average properties of radio sources with cosmological epoch have been computed for world models with $\Lambda = 0$; $\Omega = 1$ and $\Omega = 0$. These are compared with the latest observational data and previous analyses of the source counts. It is shown that exponential models are compatible with the observations and do not require a sharp cutoff in the radio source distribution at large redshifts. The luminosity function of radio sources at large redshifts must exhibit a marked maximum–minimum behaviour. The physical interpretation of different laws of cosmological evolution is discussed. (auth) (UK)

23720 HOMOGENEOUS ELECTROMAGNETIC AND MASSIVE-VECTOR-MESON FIELDS IN BIANCHI COSMOLOGIES. Hughston, Lane P. (Southwest Center for Advanced Studies, Dallas, Tex.); Jacobs, Kenneth C. Astrophys. J.; 160: 147-52(Apr 1970).

The consequences of (a) the source-free Maxwell equations and (b) the equations of massive-vector-meson fields in spatially homogeneous Bianchi cosmologies were investigated and explicit formulae were obtained for the electromagnetic field and its stress–energy tensor in the case where the Poynting vector vanishes. In the case of a pure magnetic (or electric) field, it is shown that Bianchi Types I, II, III, VI ($h = -1$), and VII ($h = 0$) admit only constrained field components, whereas Types IV, V, VI ($h \neq -1$), VII ($h \neq 0$), VIII, and IX admit no field components. It is found that diagonal Bianchi cosmologies with a massive-vector-meson field can exist only for Bianchi Types I, II, VI ($h = -1$), VII ($h = 0$), VIII, and IX. (auth)

23721 THE $2^1/_2$-POST-NEWTONIAN EQUATIONS OF HYDRODYNAMICS AND RADIATION REACTION IN GENERAL RELATIVITY. Chandrasekhar, S.; Esposito, F. Paul (Univ. of Chicago). Astrophys. J.; 160: 153-79(Apr 1970).

The equations of hydrodynamics in the $2^1/_2$-post-Newtonian approximation to general relativity are derived. In this approximation all terms of $O(c^{-5})$ are retained consistently with Einstein's field equations; it is also the approximation in which terms representing the reaction of the fluid to the emission of gravitational radiation by the system first make their appearance. (TSS)

23722 ANISOTROPIC, MULTI-FLUID COSMOLOGIES WITH HYPERSURFACE ORTHOGONAL VELOCITY FIELDS. Hughston, Lane P.; Shepley, L. C. (Southwest Center for Advanced Studies, Dallas, Tex.). Astrophys. J.; 160: 333-6(Apr 1970).

New spatially homogeneous cosmological models filled with a perfect fluid and characterized by a fluid velocity orthogonal to homogeneous hypersurfaces of constant curvature are presented. These models include an arbitrary number of fluid components which may be either noninteracting or interacting. (auth)

23723 A NEW TYPE OF ANISOTROPIC COSMOLOGICAL MODEL WITH STRESS. Kale, P. P. (Univ. of Poona). Curr. Sci. (India); 39: 180(20 Apr 1970).

Jacobs (1968) has considered one case of an anisotropic cosmological model in which he takes a metric of the form $ds^2 = -Adx^2 - Bdy^2 - Cdz^2 + dt^2$, with A, B, and C as functions of time + satisfying field equations of the form $R_{ij} - \frac{1}{2} Rg_{ij} = -8\pi T_{ij}$. As far as is known, no anisotropic solution of $R_{ij} = \lambda g_{ij}$ is known, where $g_{ij} = g_{ij}(t)$. An anisotropic solution for $R_{ij} = \lambda g_{ij}$ is given. (W.D.M.)

23724 INFLUENCE OF THE COSMOLOGICAL CONSTANT IN CLOSED-UNIVERSE MODELS CONTAINING MATTER AND RADIATION. Agnese, A.; La Camera, M.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cim.; 66B: 202-16(11 Apr 1970).

The solution of the cosmological equations in isotropic and homogeneous closed-Universe models containing simultaneously matter and radiation, having in general the cosmological constant $\Lambda \neq 0$ has been obtained. The limiting cases (matter dominating and radiation dominating) have been studied numerically. The general case is intermediate between the limiting cases. Some of the results obtained in those limiting cases are: (a) The possibility of having a closed Universe with the presently known matter density. (b) The conclusion that Λ must be positive if the age of the Universe exceeds a calculated minimum value. (c) Reasonably accurate determination of the value of Λ if the age of the Universe exceeds a minimum value. (auth)

Planetary Phenomena

Refer also to abstract 23051.

23725 (COO-1167-7) EVIDENCE FOR SOLAR FLARE PROTON INDUCED RADIOACTIVITY IN LUNAR SURFACE MATERIAL RETURNED BY APOLLO 11. Heydegger, H. R.; Turkevich, Anthony (Chicago Univ., Ill. Enrico Fermi Inst.). [1969]. Contract AT(11-1)-1167. 8p. Dep. CFSTI.

A comparison of the specific radioactivity values reported for lunar surface material from the Apollo 11 mission with analogous data for stone meteorites suggests that energetic particles from the solar flare of April 12, 1969 may have produced most of the ^{56}Co observed. (auth)

23726 ORIGIN AND DYNAMICAL BEHAVIOUR OF THERMAL PROTONS IN THE VENUSIAN IONOSPHERE. Banks, P. M.; Axford, W. I. (Univ. of California, San Diego). Nature (London); 225: 924-6(7 Mar 1970).

It is stated that an important source of thermal H^+ and/or D^+ has been overlooked in the ionosphere of Venus; this supports the choice of H^+ and/or D^+ as the dominant light ion at high altitudes. Its origin is discussed. (auth) (UK)

23727 LUNAR NEUTRON EMISSION INDUCED BY COSMIC RAYS. Gnedin, Yu. N.; Dolzinov, A. Z.; Tsygan, A. N. Kosm. Issled.; 7: 777-85(Sep-Oct 1969). (In Russian).

Neutron flux produced by cosmic-ray interactions with the lunar surface is estimated. The possibility of determining the composition of the Moon surface and, especially, the content of hydrogen by the intensity of neutron emission is discussed. (tr-auth)

23728 POSSIBILITY OF A TERRESTRIAL COMPONENT IN THE DOPPLER-SHIFTED ZODIACAL LIGHT. Vanysek, V. (Karlova Univ., Prague); Harwit, M. Nature (London); 225: 1231-2(28 Mar 1970).

It is stated that light scattered from particles in circumterrestrial space may make an appreciable contribution to the zodiacal glow, but how significant such a contribution may be is unknown. Direct observations on the circumterrestrial components of interplanetary dust are ambiguous, despite extensive particle detection experiments from space probes, and such experiments have been largely sensitive to particles larger than those thought responsible for the glow. Spectroscopic methods, although not yet sufficiently specific to permit conclusions about the circumterrestrial particles, appear to be sufficiently intrinsically selective to permit early decisive tests. In the present communication a circumterrestrial dust component is assumed and it is predicted that the low-velocity Doppler shifts observed at high elongations will be confirmed by more detailed observations and will be found present both in the morning and evening zodiacal glow. The difference between a circumterrestrial dust containing model and the pure interplanetary dust model is sufficiently large so that the techniques adopted appear capable of making a distinction. If an appreciable fraction of the dust is concentrated near the Earth it would be expected that the value of the wavelength shift would be below the theoretical curve at elongations of the order of 70°, whereas the shift for an entirely circumsolar cloud would exhibit no such drop. The wavelength shift at the evening zodiacal light as a function of elongation is shown as computed for circular orbits about the Sun. The values obtained at elongations in excess of 70° may represent the dominance of dust near the Earth. (UK)

23729 THE MICROWAVE SPECTRUM OF MERCURY. Morrison, David (Cornell Univ., Ithaca, N. Y.); Klein, Michael J. Astrophys. J.; 160: 325-32(Apr 1970).

The disk temperature of Mercury at wavelengths of 1.95 and 6.0 cm were measured; the phase-invariant components of the temperature are 350° ± 30°K and 385° ± 20°K, respectively. These data, combined with previous measurements, indicate that the time-averaged disk temperature of Mercury increases by 25% from short millimeter wavelengths of 6 cm. This departure from a thermal spectrum is probably due to an increase in temperature with depth. This temperature gradient could be maintained by a subsurface "greenhouse effect" if radiative heat conduction, which is strongly temperature-dependent, supports a large fraction of the diurnal flow of heat in Mercury's epilith. The observations are consistent with a model in which the ratio of the electrical to thermal skin depths is near unity at a wavelength of 1 cm. (auth)

23730 OBSERVATIONS OF MARS AND VENUS AT 11.1 CM. Stankevich, K. S. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys.; 23: 111-12(Feb 1970).

Radio measurements of Mars at 11.1 cm during the apposition of June 1969, gave effective brightness temperature 194 ± 10°K. Radio emissions from Venus gave mean brightness of 710 ± 35°K. (Australia)

Atomic and Molecular Physics

Refer also to abstracts 23037 and 24604.

23731 PARTICLE SPECTRA CALCULATIONS IN A MOLECULAR SYSTEM IRRADIATED BY PHOTONS. Abillon, Eliane (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 269: 1189-92(3 Dec 1969). (In French).

The energy spectra of photons and electrons are calculated in the case of an infinite homogeneous media irradiated by monoenergetic photons uniformly distributed in the media. The results are given in the case of gaseous methane for several energies of the photon sources: 1 MeV, 500, 100, 50, and 25 keV. (tr-auth)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 23042, 24107, 24144, and 24195.

23732 (IAE-1951) EXPERIMENTS ON CHARGE EXCHANGE OF FAST PLASMA CLUSTERS IN THE INES DEVICE. Zamarashkin, L. V.; Kartashev, K. B.; Pistunovich, V. I.; Platonov, V. V.; Filimonova, E. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1970. 48p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The possibility of obtaining a dense beam of hydrogen atoms with particle energies above 1 keV by means of charge exchange in a magnesium vapor target from plasma clusters generated by a coaxial plasma gun is investigated. It is shown that the charge exchange takes place in agreement with a pair collisions model for incident beam densities on the order of 10^{12} cm^{-3} and the target efficiently removes particles with energies lower than 1 keV from the beam. (tr-auth)

23733 (SC-RR-69-512) ELECTRON BEAM DIAGNOSTICS. PART I. Buckalew, William H.; Posey, Lawrence D. (Sandia Labs., Albuquerque, N. Mex.). Oct 1969. 118p. Dep. CFSTI.

Methods for performing pulsed electron beam diagnostics are presented, and techniques for determining energy deposition profiles and beam energy density are discussed. The dosimetry materials and instrumentation employed in measurements of this type are treated in detail. In addition, techniques for the determination of electron beam pulse profile as well as differential energy spectrum are considered. Representative data, obtained using the above techniques to define the electron beam output of the Sandia Model 705 Febetron and Hermes I, are included. (auth)

23734 DETERMINATION OF RANGES OF ACCELERATED IONS IN THIN OXIDE FILMS. Bach, H. (Jenaer Glaswerk Schott and Gen., Mainz). Z. Angew. Phys.; 28: 239-44(9 Jan 1970). (In German).

A method is described for the determination of the range of accelerated ions in the oxide films on glass substrates, whereby these films are sputtered by the ions. The differential range distribution of the ions is obtained from the recorded variation of the spectral luminescence intensity that occurs when the ions during uniform sputtering of the films, penetrate into a glass substrate with strong or weaker luminescence. Said method was applied for the determination of the mean range of A^+ ions of 4.2 and 5.6 keV energy in thin organogenic SiO_2 and TiO_2 films. The values ascertained for the mean specific energy losses from measurements of the ranges in SiO_2 and TiO_2 are compared with specific energy losses predicted according to a previous theory. (auth)

23735 SCATTERING OF ATOMS BY SOLID SURFACES. I. Cabrera, N.; Celli, V.; Goodman, F. O.; Manson, R. (Univ. of Virginia, Charlottesville). Surface Sci.; 19: 67-92(Jan 1970).

A quantum mechanical theory of the scattering of atoms by solid surfaces is presented. The theory is applied to a detailed discussion of elastic scattering (diffraction) processes, and the extension to inelastic scattering (phonon exchange) processes is discussed briefly. A great advantage of the theory is that scattering intensities of any size are easily handled; the moduli of the scattering matrix elements are not restricted to being small. If the results are expanded to lowest order in these moduli, then the first-order distorted-wave Born approximation is recovered. An example of the results obtained is that the intensity of the specularly scattered beam is by no means always larger than other diffracted intensities; this result is in agreement with experiments, and is a decided improvement over the usual first order treatments. (auth)

23736 SCATTERING OF ATOMS BY SOLID SURFACES. II. CALCULATIONS FOR THE ELASTIC SCATTERING OF ^{3}He AND ^{4}He BY LiF. Goodman, Frank O. (Univ. of Virginia, Charlottesville). Surface Sci.; 19: 93-108(Jan 1970).

The recent quantum mechanical theory of scattering of atoms by solid surfaces, proposed by Cabrera, Celli, Goodman and Manson (CCGM), is applied to calculations of the elastic scattering of ^{3}He and ^{4}He by LiF. The model used is a very special case of the CCGM theory; it is chosen because it allows straightforward calculations and because of its ease of interpretation. Because of uncertainties in the relevant physical parameters in the model and the effects of the simplifications and assumptions made therein, the calculations have only qualitative significance. Such calculations are useful, however, as they provide a basis for (a) discussion of the physical processes involved in elastic scattering, (b) preliminary qualitative correlation of existing experimental data, and (c) specific suggestions for future experiments.

Existing experimental data support the qualitative predictions of the model. (auth)

23737 DETERMINATION OF TOTAL CROSS SECTIONS FOR THRESHOLD EXCITATION AND IONIZATION BY ELECTRON IMPACT. Brongersma, H. H.; Boerboom, A. J. H.; Kistemaker, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 44: 449-72(Sept. 29, 1969).

Total cross sections have been determined for electronic excitation and ionization processes in helium, carbon monoxide, nitrogen, oxygen, carbon dioxide, ethylene, and benzene. The formation of transient negative ions greatly influences the behavior of the cross sections as a function of the incident electron energy. In the apparatus, the production of low-energy ions can be determined as well as the production of low-energy electrons resulting from an inelastic collision. Therefore, cross sections for excitation processes can be normalized on the well-known ionization cross sections. Assuming the value of Rapp and Englander–Golden for the formation of positive ions from carbon monoxide as a standard, the maximum in the cross section of the 2^3S excitation of helium is found to be 4×10^{-18} cm^2 which is reached at about half a volt above threshold. Maier–Leibnitz determined 5×10^{-18} cm^2 for this maximum. The maximum cross section for the formation of negative ions from O_2 near 6.5 eV is found to be 1.4×10^{-18} cm^2 Rapp and Briglia determined the same value for this process. (auth)

23738 Cu K_α/K_β X-RAY PRODUCTION FROM PROTON AND OXYGEN BOMBARDMENT. Richard, Patrick (Univ. of Texas, Austin); Bonner, T. I.; Furuta, T.; Morgan, I. L.; Rhodes, J. R. Phys. Rev., A; 1: 1044-8(Apr 1970).

K_α and K_β x rays produced in the bombardment of Cu with protons of 6- to 10-MeV incident energy were measured using a 4-mm-thick cooled Si(Li) detector with an instrumental resolution of 280 eV. The K_α/K_β transition ratios are observed to be constant over the energy range studied with a value of 7.8 ± 0.1 for proton excitation and 7.0 ± 0.1 for the oxygen excitation, compared to a previous experimental value of 7.33 for electron excitation and a calculated value of 8.2. The cross section for x-ray production at 90° to the beam direction for 7-MeV protons on Cu is 23.9 ± 3.6 b/sr and for 15-MeV oxygen on Cu is 0.88 ± 0.27 b/sr. The K_β peak produced by oxygen bombardments is observed to shift upwards in energy by 97 ± 15 eV relative to the K_β peak produced in proton bombardments. (auth)

Atomic and Molecular Properties

Refer also to abstracts 23618, 23639, 23686, 23688, 23964, 23969, 23973, and 24199.

23739 (NRL-6950) MEASUREMENT OF NITROGEN II AND CARBON II RESONANCE MULTIPLET LINE SHAPES FROM A PLASMA. Fortna, John D. E. (Naval Research Lab., Washington, D. C.). 20 Jun 1969. 82p.

The spectral line shapes of the nitrogen II and carbon II resonance multiplets, which occur in the vacuum ultraviolet region of the spectrum, have been measured. The Stark widths were deduced from the optically thin Lorentz wings. The source of radiation was a hot plasma produced by reflecting the shock wave generated by an electromagnetic T-type shock tube operating at a moderate pressure of helium gas to which the test elements (and hydrogen) were added. The electron temperature was determined from the ratio of the total intensities of the He I 4713 Å and the Hβ 4861 Å lines. The electron density was obtained from the halfwidth of the He I 3889 Å line. Measurement of the electron temperature and density of the test plasma was such as to provide a critical test of a recent semiempirical theory of Stark broadening of isolated ion lines under conditions in which the broadening electron collisions are predominantly elastic and without classical analogue. Agreement with the theory was found to within the expected precision of the theory. (auth)

23740 (ORNL-TM-2943) ELECTRON ENERGY LEVELS IN FREE ATOMS FROM Z = 1 TO Z = 60. Krause, Manfred O. (Oak Ridge National Lab., Tenn.). 7 Apr 1970. 13p. Dep. CFSTI.

Values of electron energy levels in free atoms from Z = 1 to Z = 60 were obtained by converting the Bearden and Burr's values for bound atoms with the aid of C. H. Moore's values for optical levels and theoretical values by Mann and by Froese-Fischer. With a few exceptions present values are considered to be accurate within ±2 eV. (auth)

23741 (ORNL-tr-2295) COMBINED STARK AND ZEEMAN EFFECTS ON THE HYDROGENOID TRANSITIONS OF NEUTRAL HELIUM. Deutsch, C.; Drawin, H. W.; Herman, L.; Hguyen-Hoe. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Quant. Spectrosc. Radiative Transfer; 8: 1027-59(1968). 33p. Dep. CFSTI.

The perturbation theory of Waller and Foster (WF) for hydrogenic lines of neutral helium is generalized in order to take into account an external magnetic field H having an arbitrary angle with respect to an external constant electric field F. The diagonal correction was evaluated numerically, taking into account recent experimental data. A FORTRAN IV program written for the CDC 3600 computer allows the calculation of the displacements and the intensities for any hydrogenic transition. Special attention is given to the $n' = 2 \rightarrow n = 4$ and $n' = 2 \rightarrow n = 5$ transitions in neutral helium. The corresponding spectral components were studied carefully for parallel and perpendicular fields. The calculated displacements are in excellent agreement with those determined experimentally. The calculations confirm Foster's observations, that the intensities of the components become asymmetric if magnetic and electric interactions are of comparable strengths, and t that there exists a strong mutual interaction between the components for perpendicular fields. In the latter case, the asymmetry increases with increasing orbital quantum number l. The shift and intensity of some spectral components belonging to the He I transition $\{2\text{-}4\}_{ortho}$, $\{2\text{-}5\}_{ortho}$, $\{2\text{-}4\}_{para}$, and $\{2\text{-}5\}_{para}$ are given in graphical form for three constant electric-field strengths, 5, 50, and 100 kV/cm, with the magnetic-field strength ranging from 0.2 kG to 80 kG. In two tables, experimental and theoretical shifts of the components belonging to the transitions $2^3P \rightarrow 5^3S$, 5^3P, 5^3D, 5^3F, and 5^3G, and $2^1P \rightarrow 5^1S$, 5^1D, 5^1F, and 5^1G are listed, thus permitting a numerical comparison of the theoretical calculations with the experimental results of Foster and Pounder (H = 25.8 kV, F = 64 kV/cm, $H \perp F$) and Lebowsky and Steubing (H = 32 kΓ, F = 13.9 kV/cm, $H \perp F$). In graphs and tables, all shifts are counted from the unperturbed transitions 2P–4D or 2P–5D, respectively. (auth)

23742 OSCILLATOR STRENGTHS OF THE SPECTRAL LINES OF Tm I AND Yb I. Komarovskii, V. A.; Penkin, N. P. Opt. Spectrosc. (USSR)(Engl. Transl.); 26: 483-4(Jun 1969).

Translated from Opt. Spektrosk.; 26: 882-5(Jun 1969).

The relative oscillator strengths of 41 lines of the thulium atom and 5 lines of the ytterbium atom, located in the 6000- to 2450-Å region, are determined by the hook method of D. S. Rozhdestvenskii. The absolute value of $f(f_{ki} = 1.12 \pm 0.04)$ for Yb I 3987.98 Å is determined by simultaneously measuring the total absorption value and the hooks. This gives absolute f values for all five Yb I lines and permits calculation of the probabilities of the corresponding transitions. (auth)

23743 CALCULATION OF THE ENERGY LEVELS OF La II $4f5d$, Ce I $4f5d6s^2$, Pr IV $4f5d$, $4f6s$ Eu II $4f^7(^8S)5d$, Gd I $4f^7(^8S)5d6s^2$. Eremin, M. V.; Maryakhina, O. I. Opt. Spectrosc. (USSR)(Engl. Transl.); 26: 479-83(Jun 1969).

Translated from Opt. Spektrosk.; 26: 873-81(Jun 1969).

The energy levels of the electron configurations La II $4f5d$, Ce I $4f5d6s^2$, Pr IV $4f5d$, $4f6s$, Eu II $4f^7(^8S)5d$, and Gd I $4f^7(^8S)5d6s^2$ were calculated. For Pr IV, consideration was given to electrostatic interaction between the $4f5d$ and $4f6s$ configurations and it was shown that the description of the energy-level schemes improves accordingly. The mean square errors of the calculated energy levels are 623, 600, 259, 95, and 122 cm^{-1} La II, Ce I, Pr IV, Eu II, and Gd I, respectively. The calculated g-factors show good agreement with the experimental g-factors. The parameters of the electrostatic and spin-orbital interactions were determined. The behavior of the $4f^n5d$ electron configurations was also examined for different ionic charges and in the isoelectronic sequence. (auth)

23744 MAGNETIC INTERACTIONS BETWEEN ELECTRONS IN HEAVY ATOMS. Judd, B. R. (Johns Hopkins Univ., Baltimore). Comments At. Mol. Phys.; 1: 173-6(Feb-Mar 1970).

The problem of including magnetic interactions, spin–spin and spin–other-orbit, between electrons in heavy atoms in term analyses for complex atomic spectra is reviewed. An approach involving the six parameters M^k and P^k applicable to rare earths is described briefly. An analysis along these lines has been performed for $4f^3$ configurations with the result that experimental energy levels were fit to a mean error of roughly 10 cm^{-1}. 16 references. (A.G.W.)

23745 NEW QUADRUPOLE AND FORBIDDEN LINES IN THE L EMISSION SPECTRUM OF NEODYMIUM. Gokhale, B. G.; Shukla, S. N. (Lucknow Univ., India). J. Phys.; B (London); 3: 438-42(Mar 1970).

A detailed study, using a 40-cm curved-crystal transmission (Cauchois-type) spectrograph, has revealed for the first time the existence of four new diagram lines at 1745.5, 1765.6, 1841.2, and 1994.0 x.u. in the L-emission spectrum of neodymium. The lines

have been ascribed, in that order, to the forbidden transition L_IO_I and the quadrupole transitions $L_IN_{IV,V}(\gamma_{II})$, $L_{II}N_{VI,VII}(\gamma_I')$, and $L_{III}N_{VI,VII}(\beta_7')$. The presence of three more lines $\gamma_{4,4'}(L_IO_{II,III})$, $\eta(L_{II}M_I)$ and $\gamma_8(L_{II}O_I)$ has been confirmed, the first two having been hitherto measured only by Coster (1922) and the third only by Dauvillier (1923). The measurements of previously known dipole and quadrupole lines are compared with those of earlier workers. (auth) (UK)

23746 ON THE L AUGER LINES IN THE BETA-RAY SPECTRUM OF THE ACTIVE DEPOSIT OF THORON. II. Slaetis, Hilding; Rockberger, Musa (Research Inst. for Physics, Stockholm). Ark. Fys.; 40: 49-70(1969).

The method for detecting very weak, photographically recorded spectral lines and the intensity rule for the Auger electron transitions in the heavy element region proposed in previous papers were further tested in the present work. A plate covered with a thin layer of "Nuclear Research Emulsion in Gel Form, G.5" was exposed in 1957 to electrons from an active deposit of thoron. This plate was later in the same year investigated by Sujkowski and Slaetis, who found 54 L Auger lines, 47 of which were interpreted. The present paper gives the result of a reinvestigation of the old 1957 plate. Now 255 L Auger lines were found, 22 of them, however, not certain. All lines were interpreted. The thoron L Auger lines found were compared with the 37 lines found by Geoffrion and Nadeau, with the 54 found by Sujkowski and Slaetis, with the 29 lines from ^{203}Tl found by Sujkowski and Melin and with the 65 lines from ^{210}Bi found by Haynes, Velinsky and Velinsky in 1965. The intensity rule, was confirmed also for the Bi and Tl LMM, LMN, and LNN Auger lines. (Sweden)

23747 CALCULATION OF THE OPTICAL POLARIZABILITY OF THE HYDROGEN ATOM IN THE 2s AND 2p STATES. Adamov, M. N.; Balmakov, M. D.; Rebane, T. K. Opt. Spectrocs. (USSR) (Engl. Transl.); 27: 100-101(Jul 1969).

Translated from Opt. Spektrosk.; 27: 189-91(Jul 1969).

The results of variational calculations of the optical polarizability $\alpha(\omega)$ for the $2s\sigma$, $2p\sigma$, and $2p\pi$ states of the hydrogen atom are presented. These results can be used to determine the optical polarizability of any superposition of the 2s and 2p states. (A.G.W.)

23748 SEARCH FOR INFLUENCES OF HIGH ELECTROSTATIC FIELDS ON B'NDING ENERGIES OF INNER ATOMIC SHELLS. Erman, Peter (Research Inst. for Physics, Stockholm). Ark. Fys.; 39: 451-9(Oct 1969).

Experiments were made with radioactive atoms implanted in matter and exposed to high electrostatic fields. Using various special techniques in connection with beta and gamma spectroscopy, the atomic binding energies of inner shells were studied. In particular, for uranium atoms imbedded in aluminum oxide and exposed to a field of $(7.5 \pm 0.8) \times 10^6$ V/cm no shifts of the atomic binding energies were observed greater than or equal to 1 eV (L2 shell), greater than or equal to 4 eV (L3 shell), greater than or equal to 15 eV (M2, M3 shells), or greater than or equal to 5 eV (N3 shell). This should be compared to earlier reported level shifts of about 100 eV in uranium atoms exposed to fields of 10^6 to 10^7 V/cm under different experimental conditions. (auth) (Sweden)

23749 DIPOLE POLARIZABILITIES OF THE $2\,^{1,3}S$ STATES IN THE HELIUM ISOELECTRONIC SEQUENCE. Stewart, A. L. (Queen's Univ., Belfast). J. Phys., B (London); 2: 1309-12(Dec 1969).

Perturbation theory is used to calculate the dipole polarizability of the $1s2s\ ^{1,3}S$ states of the helium isoelectronic sequence. Good agreement is obtained with the very accurate calculations made by Chung and Hurst in 1966 in the case of He and Li^+. (auth) (UK)

23750 ANALYSIS OF THE HYPERFINE STRUCTURE OF THE GROUND-STATE MULTIPLET OF THE SAMARIUM ATOM. Rosen, A. (Chalmers Univ. of Tech, Goteborg). J. Phys., B (London); 2: 1257-60(Dec 1969).

Relativistic radial hyperfine structure integrals were calculated for the ground-state configuration of the samarium atom by use of relativistic Hartree–Fock–Slater wave functions. Comparison is made with experimentally determined parameters for the dipole interaction for ^{147}Sm and the agreement is better than 5%. The quadrupole moment for this isotope is calculated to be $Q^{147} = -0.18(3)$ bn. (auth) (UK)

23751 ANALYTICAL ORBITAL WAVE FUNCTIONS FOR THE TWO-ELECTRON ATOM. McEachran, R. P.; Cohen, M. (York Univ., Toronto). J. Phys., B (London); 2: 1271-3(Dec 1969).

Orbital wave functions for a number of singlet and triplet P and D states of neutral helium were calculated within the framework of the 'frozen core' approximation. The radial equation was solved using a matrix method, which leads to analytical wave functions more convenient in many applications than numerical Hartree–Fock orbitals of similar accuracy. (auth) (UK)

23752 THE USE OF COAXIAL PLASMA SOURCES FOR IDENTIFICATION OF ATOMIC SPECTRA. Dontsov, Yu. P.; Korostylyova, L. A.; Morozov, A. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 26: 487-9(Jun 1969).

Translated from Opt. Spektrosk.; 26: 890-5(Jun 1969).

The use of an electromagnetic plasma accelerator is proposed for the identification of the spectra of neutral atoms and the spectra of ions of different degrees of ionization. In sources of this sort, for example in a quasi-stationary coaxial accelerator, at low plasma densities the neutral atoms are not accelerated, whereas the velocity of the ions is proportional, to a first approximation, to the square root of their charge to mass ratio. The assignment of the spectral lines to any particular spectrum is based on the Doppler shift of the given line. The design of the source and measuring technique are described. Results of testing the method with some lines in the Cu, Al, and Sm spectra are presented. (auth)

23753 TEMPERATURE DEPENDENCE OF HYPERFINE PRESSURE SHIFTS. I. DEUTERIUM IN HELIUM FROM -135 TO 400°C. Wright, J. J.; Balling, L. C.; Lambert, R. H. (Univ. of New Hampshire, Durham). Phys. Rev., A; 1: 1018-21(Apr 1970).

Spin-exchange optical pumping was used to measure the hyperfine pressure shift of deuterium in helium as a function of temperature. A new technique for optical pumping at low temperatures was combined with a previously reported technique for optical pumping at high temperatures to make measurements between −135 and 400°C. The experimental results are compared with existing theoretical calculations. (auth)

23754 CONFIGURATION-INTERACTION WAVE FUNCTIONS FOR TWO-ELECTRON SYSTEMS. Joachain, C. J.; Vanderpoorten, R. (Univ. Libre, Brussels). Physica; 46: 333-43(9 Mar 1970).

Correlated wave functions of the configuration-interaction type are constructed for the ground state and several excited states n^1L ($n = 2, \ldots 6$, $L = 0, \ldots 5$) of the helium atom. Radial and angular correlation effects are investigated. The relative merits of different sets of basis functions are compared. The H^- ion and the 2^3S state of helium are also studied. (auth)

23755 UPPER AND LOWER BOUNDS TO EXPECTATION VALUES. Mazziotti, Alexander; Parr, Robert G. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 52: 1605-6(1 Feb 1970).

A method for determination of upper and lower bounds to expectation values is described briefly. As an illustration, upper and lower bounds to $\langle 1/r \rangle$ for the hydrogen and helium atoms are given. It is suggested that very accurate bounds on properties such as magnetic susceptibility and nuclear magnetic shielding for the helium atom should now be obtainable. (A.G.W.)

23756 WAVE FUNCTIONS WITH ANGULARLY DEPENDENT ORBITAL EXPONENTS FOR HeH^+. Hayns, M. R.; Banyard, K. E. (Univ. of Leicester, Eng.). J. Chem. Phys.; 52: 1609-11(1 Feb 1970).

Values for a correlated function (σ,σ') centered on He and for the noncorrelated form $(\sigma)^2$ are tabulated. Allowance for the effects of electron correlation and molecular formation introduced internally within the model are discussed in terms of changes in the electron density. Density difference maps illustrating these effects are shown. Results are compared with those derived from a single-center extensive configuration interaction treatment for HeH^+. (A.G.W.)

23757 SPIN–ORBIT INTERACTION TERMS FOR THE p^2–p', p^2–d, AND p^2–f CONFIGURATION. Koozekanani, S. H. (Ohio State Univ., Columbus). J. Chem. Phys.; 52: 1614-15(1 Feb 1970).

Spin-orbit interactions terms for all the states arising from p^3–p' p^3–d, and p^3–f configuration were calculated. Tables of these terms are available from the National Auxiliary Publication Service. (A.G.W.)

23758 PADE APPROXIMANTS TO THE NORMAL DISPERSION EXPANSION OF DYNAMIC POLARIZABILITIES. Langhoff, P. W.; Karplus, M. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 52: 1435-49(1 Feb 1970).

A procedure for investigating the dispersion of dynamic polarizabilities and associated molecular excitation spectra is presented. The time-dependent Schrödinger equation is replaced through the expedient of an ansatz by a frequency-dependent equivalent and the pertinent first-order perturbation function expanded in a power

series in the applied frequency. There results a set of coupled inhomogeneous differential equations that can be solved sequentially by utilizing the methods for static polarizability calculations, providing the coefficients for a power-series expansion in frequency of the polarizability (Cauchy series). The latter is identified as a series of Stieltjes, which can be summed within and continued outside its radius of convergence by Padé approximants, furnishing an approximation to the polarizability throughout the entire (cut-) complex plane. The power-series coefficients from the expansion of the polarizability further provide a test of the convergence of the computation, which is independent of applied frequency. Applications are made in the dipole case to atomic hydrogen, for which exact solution for the expanded perturbation function is calculated, and to the helium atom and hydrogen molecule in the coupled Hartree–Fock approximation (time-dependent Hartree–Fock theory), for which the equations are solved using a convenient variational procedure. Lower-bounded rapid convergence to the correct polarizabilities and associated refractivities in the normal dispersion region is obtained using a small number of Cauchy coefficients and the lowest-order Padé approximants. Further, accurate approximations to the lowest-lying transition frequencies and oscillator strengths are obtained from the poles and residues, respectively, of the Padé approximants. These results indicate that variational computations of optical susceptibilities in the normal dispersion region, combined with subsequent summation and analytical continuation in frequency, can provide a practical procedure for investigating the optical dispersion and excitation spectra in atomic and molecular systems. (auth)

23759 SEPARATED WAVE FUNCTIONS FOR THE GROUND STATE OF TWO-ELECTRON ATOMS. Carlton, Terry S.; Hull, William E. (Oberlin Coll., Ohio). J. Chem. Phys.; 52: 1169-73(1 Feb 1970).

Partially separated wavefunctions of the form $U(r_1,r_2)W(r_{12})$ yield helium ground-state energies in error by as little as 4×10^{-4} a.u. Completely separated functions $F(r_1)F(r_2)W(r_{12})$ give distinctly poorer results. The correlation function $W(r_{12}) = (1 + Br_{12})^{\frac{1}{2}}$ yields energy errors of less than 1×10^{-3} a.u. for H^-, He, and Li^+. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 24518 and 24605.

23760 THE ENERGY SHIFT DUE TO THE VACUUM POLARIZATION IN THE μ-MESONIC ATOM. Kim, K. Y. (Univ. of Saskatchewan, Regina). New Phys. (S. Korea), Suppl.; 9: No. 1, 49-52(Nov 1959).

The relative energy-level shift due to the second-order vacuum polarization in the μ-mesonic atom in the presence of an atomic electron was calculated. It was found that the magnitude of the calculated shift in the μ-mesonic atom of $Z = 2$ is 0.56×10^{-6} eV. (auth)

23761 SCREENING OF MUONS BY ELECTRONS IN MUONIC ATOMS. Fricke, B. (Univ., Frankfurt am Main). Lett. Nuovo Cim.; 2: 859-62(21 Dec 1969).

Calculations on electron screening were made in a total self-consistent way by using a Hartree–Fock–Slater program in which the electrons as well as the muon are included. The muon binding energies for Pb for different levels and the observable effect of the electron screening on energies of various transitions are tabulated for different numbers of electrons. The shifts in binding energy for the different electron configurations are quite large (17 keV in the case of 81 electrons), but the absolute value is nearly equal for the muon in the different levels. The observable effect in the transition energies is very small. (A.G.W.)

23762 PSEUDOPOTENTIAL CALCULATION OF POSITRON ANNIHILATION IN BERYLLIUM. Shand, J. B. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Phys. Lett.; 30A: 478-9(15 Dec 1969).

A local pseudopotential model for conduction electrons in beryllium, chosen to fit the Fermi surface, was used to calculate the angular correlation of photon pairs from annihilation of positrons in beryllium. (auth)

23763 TEMPERATURE EFFECT OF POSITRON ANNIHILATION IN SINGLE CRYSTALS. Dekhtjar, I. Ya. (Inst. of Metal Physics, Kiev). Phys. Lett.; 30A: 462-3(15 Dec 1969).

A positron annihilation mechanism in single crystals is proposed that allows one to interpret the temperature effect previously observed. (auth)

23764 SCATTERING LENGTHS AND LEVEL SHIFTS IN MESONIC ATOMS. Seki, Ryoichi (Univ. of Georgia, Athens). Phys. Rev., D; 1: 107-10(1 Jan 1970).

A formula relating the level shifts and widths to the meson–nucleus scattering lengths is examined for a momentum-dependent potential of general form, using a simple argument similar to that of Bethe and deHoffmann and Coulomb effective-range theory. (auth)

23765 POSITRON DIFFUSION AND ANNIHILATION IN HELIUM. Leung, C. Y.; Paul, D. A. L. (Univ. of Toronto). J. Phys., B (London); 2: 1278-92(Dec 1969).

The diffusion and annihilation of slow positrons were studied by the method of delayed coincidences for helium at 77°K and densities of 20 to 70 amagat. The nonexponential shoulder in the free-positron component is confirmed and has a total breadth of more than 1300 ns amagat, corresponding to a Ramsauer–Townsend-type minimum in the diffusion cross section Q of about 0.031 πa_0^2 at an energy of 1.7 eV. Application of electric fields of up to 33 V cm^{-1} $amagat^{-1}$ failed to enhance positronium formation, contrary to the findings of Marder et al. Q was found to be >0.115 πa_0^2 around 17.7 eV. Z_{eff} is found to be 3.677 ± 0.025 at thermal energy, dropping to about 3.3 near 1 eV, in agreement with recent experiments of Lee and Jones. Drachman's theoretical s-wave phase shifts (quasi-lower bounds) appear to be very reliable and an upper limit was set on these phase shifts by constructing intermediate values and comparing thermalization times with experiment. Drachman's values of Z_{eff} are a few per cent too low below $v = 0.8$ $ryd^{\frac{1}{2}}$, but probably not anywhere by more than 8%. The variation of the positronium annihilation rate with pressure fits an approximately parabolic form above 40 amagat, resembling similar results of Celitans et al. for oxygen-free argon, but at lower densities in helium this annihilation rate becomes anomalous. (auth) (UK)

23766 POSITRON ANNIHILATION STUDIES IN OXIDES. Sen, P.; Patro, A. P. (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cim.; 64B: 324-36(11 Dec 1969).

Measurements were made on twenty oxides by conventional lifetime technique, three-photon lifetime technique and three-to-two-photon relative-yield technique. The results show that the presence of air, moisture, and absorbed gases affects the lifetimes and intensities to a great extent. Ortho-positronium lifetimes in a few oxides were measured and found to agree with the theoretical value of 1.4×10^{-7} sec. (auth)

23767 SELF-CONSISTENT-FIELD THEORY FOR ONE-POSITRON MANY-ELECTRON SYSTEMS. Schrader, David M. (Marquette Univ., Milwaukee. Argonne National Lab., Ill.). Phys. Rev., A; 1: 1070-80(Apr 1970).

A theory for the structure of one-positron many-electron atoms and molecules in bound states is presented. The purpose of the theory is to permit the accurate calculation of positron lifetimes, angular correlation for two-photon annihilation, and accurate positron binding energies, but not necessarily quantities that depend upon purely electronic correlation. Therefore, a modified orbital approximation is used for the electrons, the modification consisting of the introduction of explicit electron–positron correlation into each electronic orbital. The kinetic energies of the electrons and positron are treated on the same footing, and the Born–Oppenheimer approximation is applied to the nuclei. No spin-dependent or relativistic terms are included in the Hamiltonian. Only those systems for which the electrons constitute a closed shell are treated and the spatial symmetry of the atom or molecule is not considered. (auth)

23768 ANNIHILATION OF POSITRONS IN ARGON AT HIGH DENSITIES. Tao, S. J. (New England Inst., Ridgefield, Conn.). Phys. Rev., A; 1: 1257-60(Apr 1970).

The annihilation of positrons in argon as a function of argon density at densities from 10 to 65 amagats was investigated at room temperature. The direct annihilation rate, the reciprocal of shoulder width, and the quenching rate of o-positronium are found to be linearly dependent on argon density in the density range investigated within the range of the experimental error. The value of Z_{eff} of the direct annihilation rate is found to be 26.2 for an argon density up to 50 amagats. (auth)

23769 MEASUREMENT OF THE VACUUM POLARIZATION IN MUONIC ATOMS. Backenstoss, G.; Charalambus, S.; Daniel, H.; von der Malsburg, Ch.; Poelz, G.; Povel, H. P.; Schmitt, H.; Tauscher, L. (CERN, Geneva). Phys. Lett.; 31B: 233-6 (16 Feb 1970).

The vacuum polarization corrections of the muonic $4f \rightarrow 3d$ and $5g \rightarrow 4f$ transitions in Bi and Pb were measured. The over-all accuracy obtained for the vacuum polarization correction is 1%.

Experiment and theory agree if higher-order corrections are taken into account. (auth)

Collision Phenomena

Refer also to abstracts 23040, 23044, 23564, 23987, 23988, and 24190.

23770 (ANL-Trans-816) BORN EFFECTIVE CROSS SECTIONS OF ELECTRON EXCITATION OF ATOMS. Vainshtein, L. A.; Sobel'man, I. I. Translated for Argonne National Lab., Ill., from J. Quant. Spectrosc. Radiative Transfer; 8: 1491-1526 (1968). 29p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 43864.

23771 (CALT-767-P-8-X-1) APPLICATION OF ION CYCLOTRON RESONANCE TO THE STUDY OF ION-MOLECULE INTERACTIONS. Technical Progress Report, April 1, 1969-December 31, 1969. Beauchamp, Jesse L. (California Inst. of Tech., Pasadena). Contract AT(04-3)-767-8. 33p. Dep. CFSTI.

The development of the ion cyclotron resonance spectrometer and the high-pressure mass spectrometer for studying ion-molecule reactions is outlined. Studies relating to nonreactive ion-neutral collision phenomena, reactive ion-neutral collision phenomena, and particle impact excitation phenomena are briefly discussed. (W.H.K.)

23772 (CEA-N-1271) STUDY OF THE AVERAGE IONIZATION ENERGY IN GASEOUS MIXTURES. Rolland, Jacqueline (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1970. 91p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

Measurements of W, the average energy of ionization by α particles, were carried out in pure Ar and Kr, in the binary mixtures $Ar-CH_4$, Ar-Kr, $Kr-CH_4$, $Ar-H_2$, and in the ternary mixtures $Ar-CH_4-H_2$ and $Ar-CH_4-Kr$. The results obtained for the $Ar-H_2$ mixture are in good agreement with the law giving the variation of W for binary mixtures. In the concentration range studied, the same law can be applied to the $Ar-CH_4-H_2$ mixture if the $Ar-CH_4$ mixture is considered as a single component. The results obtained for Ar-Kr and $Ar-CH_4-Kr$ mixtures show that krypton and methane behave differently with respect to the various excited states of the argon atoms. A series of reactions that can explain the experimental data is given, in particular for the Ar-Kr mixture. (auth) (France)

23773 POPULATION OF EXCITED STATES IN THE ION-ION RECOMBINATION REACTION DUE TO A TWO-BODY COLLISION. Komarov, I. V.; Pogorelyi, P. A.; Tibilov, A. S. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 105-8(Aug 1969).

Translated from Opt. Spektrosk.; 27: 198-203(Aug 1969).

A calculation is carried out for the case in which an electric level (E_c) of an excited atom B is produced as a result of an ion-ion recombination reaction (IIR) resulting from a two-body collision: $A^- + B^+ \rightarrow A + B^*$. The calculation with respect to the problem of IIR leads to a study of the motion of charged particles in the field of a positive charge and a well of small radius. The results obtained with the aid of the method developed are in good agreement with the results of Bates and Boyd for the $H^- + Na^+$ reaction, with which the authors constructed a laser. A method is proposed for the selection of pairs of ions for creation of a laser by IIR. (auth)

23774 APPLICATION OF THE PSEUDOPOTENTIAL METHOD TO ATOMIC SCATTERING. Laghos, Panayiotis Sophocleous. Baton Rouge, La.; Louisiana State Univ. (1969). 62p.

Thesis.

The empirical pseudopotential method is discussed. Wave functions for the free sodium and cesium atoms that agree well with the exact valence electron functions at large distances are obtained by numerical solution of the wave equation incorporating the pseudopotential. A Heitler-London calculation is made for the lowest singlet and triplet states of the Na-Cs system. The difference in energies of these states is used in the calculation of the spin exchange cross section in collisions of sodium and cesium atoms. The scattering phase shifts are calculated in the JWKB approximation, and the cross section computed from them is averaged over a Boltzmann distribution of relative velocities. At a temperature of 500°K, the averaged reduced spin exchange cross section is $1.48 \times 10^{-14} cm^2$. The effect of elastic scattering on the cross section for electronic excitation in the collisions of slow atoms interacting by Van der Waals forces is estimated, and found to be small in usual circumstances. (Diss. Abstr.)

23775 HYDROGEN ATOM SCATTERING. Stwalley, William Calvin. Cambridge, Mass.; Harvard Univ. (1968). 372p.

Thesis.

The velocity dependence of the total cross section for the scattering of H from Hg, Kr, Xe, H_2, SF_6, and C_2H_4 is reported in the velocity range ~5 to 17×10^5 cm/sec (0.1 to 1 eV). These molecular beam experiments may conveniently be divided into two groups on the basis of the strength of the interaction potential: (1) H + Kr, Xe, H_2, SF_6, and C_2H_4 — scattering from a weak "van der Waals" potential, in which case quantum effects ("structure") are neither expected nor observed. (2) H (and D) + Hg — scattering from a moderately strong "chemical" potential, for which quantum effects are expected and observed. For the "van der Waals" systems (Group 1), the experiments are in good agreement with previous results and provide estimates for the product ϵr_m (ϵ being the potential well depth, r_m the potential minimum). The ratios of these strength parameters ϵr_m are particularly well determined for Xe and Kr (and also Ar studied in previous experiments). Semiempirical correlations of these with other scattering results suggest that as far as interaction with the rare gases is concerned, H interactions are similar to those for He and H_2 but unlike those for the alkali metals. The H + Hg results show structure in the velocity dependence of the total cross section that is ascribed to quantum effects. These quantum effects are quite sensitive to the details of the interaction potential, indicating, for example, that the Lennard-Jones (12,6) is inadequate here. An accurate potential for HgH is obtained in certain regions of internuclear distance from spectroscopic information and calculation of long-range forces. Unfortunately an intermediate region of uncertainty remains (pending anxiously awaited spectroscopic results); this prevents the accurate comparison at this time of the scattering results with purely theoretical calculations using a potential form derived from nonscattering sources, although some rough agreement has been obtained. (TSS) (Diss. Abstr.)

23776 CLASSICAL COLLISIONS AND THE CORRESPONDENCE PRINCIPLE. Percival, I. C.; Richards, D. (Univ. of Stirling, Scotland). J. Phys., B (London); 3: 315-27(Mar 1970).

An outstanding problem in the classical theory of atomic collisions has been its inability to produce the correct logarithmic dependence of certain excitation cross sections. It is shown that this is because the wrong correspondence has been made between classical and quantum mechanics. Bohr's correspondence principle for spontaneous transitions is extended to include transitions induced by external fields in those situations in which quantal perturbation theory is valid and classical perturbation theory is also valid for the corresponding classical model. On applying this principle to collisions of charged particles with highly excited hydrogen atoms a high-energy (E) cross section $\sigma(n \rightarrow n')$ of the correct form is obtained. (auth) (UK)

23777 IONIZATION OF NEUTRAL ATOMS WITH OUTER 2p, 3s, AND 3p ELECTRONS BY ELECTRON AND PROTON IMPACT. Peach, G. (University Coll., London). J. Phys., B (London); 3: 328-49(Mar 1970).

Cross sections for the removal by electron and proton impact of a 2s or 3s electron from the inner shell of all the neutral atomic systems in the sequences boron to neon and aluminum to argon, respectively, are calculated using the Born and Ochkur (1964) approximations. Contributions to these cross sections also come from doubly excited states of the neutral systems that then autoionize, and these have also been included. It is found that the cross section for the removal of an s electron can be comparable to that for the removal of an outer p electron. Earlier calculations on the ejection of the outer s electron from sodium and magnesium are repeated and compared with calculations for the ejection of a 2p electron from the inner shell. (auth) (UK)

23778 THE SHAPE AND SHIFT OF THE RESONANCE LINES OF Ca^+ PERTURBED BY ELECTRON COLLISIONS. Barnes, K. S.; Peach, G. (University Coll., London). J. Phys., B (London); 3: 350-62(Mar 1970).

The impact theory of Baranger (1958), in which the perturbing particles are treated quantum mechanically, is clarified and extended to give a general relatively simple expression for the width and shift of an isolated line using an LS coupling scheme to describe the radiating atomic system. For the case of a radiating positive ion this result is shown to be free of explicit dependence on the phase shifts for Coulomb scattering. The width and shift of the resonance lines in Ca^+ perturbed by electron collisions are then calculated using the scattering data of Burke and Moores (1968), and the results are in reasonable agreement with existing semiclassical estimates. The discrepancy between theory and experiment is partially resolved. (auth) (UK)

23779 BEHAVIOUR OF LOW-VELOCITY INELASTIC CROSS SECTIONS FOR ATOMIC REACTIONS. Janev, R. K.; Pesic, S. S. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). J. Phys., B (London); 3: 369-78(Mar 1970).

In the frame of the two-state approximation and the impact-parameter method the breakdown of Massey's adiabatic hypothesis for the electron transfer atomic reactions in the low-energy region is shown. The range of velocities where the exponential dependence of single- and double-electron capture transforms itself to a polynominal one is determined. For the reactions $H^+ + Ne \rightarrow H + Ne^+$ and $H^+ + Ne \rightarrow H^- + Ne^{2+}$ the cross sections and the adiabatic parameters are calculated. (auth) (UK)

23780 COMPETITIVE PROCESSES IN FORMATION OF NEGATIVE IONS IN HEAVY-PARTICLE COLLISIONS. Cobic, B.; Vujovic, M.; Matic, M. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). J. Phys., B (London); 3: 374-9(Mar 1970).

The processes of negative-ion formation during the passage of fast singly charged ions through gaseous targets were investigated for O^+, C^+, and O_2^+ in the energy range 5 to 30 keV using the beam technique. Two-electron capture cross sections were measured for the investigated elements, and their values varied in the range 10^{-18} to 10^{-16} cm^2. The competition of two-step processes in the formation of negative ions was found in some cases. The analysis of the appearance of two-step processes in the formation of negative ions is discussed for the gas target thickness range 10^{-3} to 10^{-2} torr cm. (auth) (UK)

23781 SEMICLASSICAL TREATMENT OF ATOMIC COLLISIONS. Bates, D. R.; Crothers, D. S. F. (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A; 315: 465-78(10 Mar 1970).

The semiclassical treatment of atom–atom collisions involving electronic transitions is discussed. As is well known, difficulties occur if the classical trajectories associated with the various states of importance in a collision process differ significantly. A method designed to overcome these is described. It will be referred to as the forced-common-turning-point method. The four coupled first-order differential equations that describe the new version of the semiclassical two-state treatment for an atom–atom collision may be reduced to a pair of generalized impact-parameter equations. The first Born approximation to the cross section obtained from the straightforward semiclassical treatment differs from the corresponding cross section obtained from the full quantal treatment mainly in that it contains an anomalous multiplying factor equal to the ratio of the initial to the final velocity of relative motion. This anomaly does not arise with the forced-common-turning-point method. A model collision process that provides a very searching test is considered. Only two states are included. The initial interaction is zero, the final interaction is Coulombic and the transition matrix element is exponential. Curve crossing may occur. The distorted-wave approximation to the excitation cross section may be found exactly and may be computed using the forced-common-turning-point method. There is remarkable accord between the results. Thus in a case where the reduced mass of the colliding systems is 2 on the chemical scale, where the excitation energy is 3.4 eV, and where the incident kinetic energy of relative motion is only 0.85 eV above this, the excitation cross sections obtained differ by as little as 0.01%; and, moreover, the patterns of the contributions to the cross sections from the separate partial waves are similar. (auth) (UK)

23782 REMARKS ON THE THEORY OF INELASTIC ELECTRON–ATOM COLLISIONS. Fano, U. (Univ. of Chicago). Comments At. Mol. Phys.; 1: 159-65(Feb-Mar 1970).

The requirements for a realistic treatment of excitation are explored by studying a partial map of e–H two-electron wave functions. The known bias of truncated close-coupling expansions toward overestimating inelastic cross sections is illustrated. (A.G.W.)

23783 A METHOD FOR STUDYING CHARGE-TRANSFER PROCESSES OF PROTONS BY DOPPLER-SHIFTED BALMER LINES. Clement, M.; Hess, W. R.; Stevenin, P. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Lett.; 31A: 326-7(23 Mar 1970).

An optical technique, using Doppler-shifted Balmer lines, was tested to study electron capture into excited levels n = 3, 4, 5 by 0.1- to 1.5-keV protons passing through H_2, D_2, He, and Ar. (auth)

23784 DIFFERENTIAL CROSS SECTION FOR VIBRATIONAL EXCITATION OF CO BY SLOW-ELECTRON COLLISION. Itikawa, Yukikazu (Univ. of Tokyo). J. Phys. Soc. Jap.; 28: 1062-6(Apr 1970).

By using the close-coupling method, differential cross sections are calculated for the vibrational excitation v = 0 – 1 of CO by electron collisions. First, the dipole interaction is considered to be responsible for the vibrational transition and the result is compared with the Born calculation. It is found that the Born result agrees well with the close-coupling calculation in the region of small scattering angles ($\lesssim 30°$), although the agreement is rather poor for the total (integrated) cross section. Next, the effect of the target polarization is investigated. Finally, the angular dependence of the vibrational cross section is evaluated by taking both the dipole and the polarization interactions into account simultaneously, and a comparison is made with experimental data. For small-angle scattering, good agreement is obtained for the theoretical and experimental cross sections, while they differ significantly from each other in the region of large scattering angles. (auth)

23785 THE 2 ^{1}S AND 2 ^{1}P EXCITATIONS OF He BY PROTON AND ELECTRON IMPACT. Flannery, M. R. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Phys., B (London); 3: 306-14(Mar 1970).

The 2 ^{1}S and 2 ^{1}P excitations of helium by electron and proton impact are considered by use of Born, two-state, and four-state versions of the impact-parameter treatment. The cross sections so obtained are modified by a transformation that takes account (in a plane-wave approximation) of the maximum and minimum momentum changes that occur during the collision. Agreement with the accurate Born values of Bell et al. (1968 and 1969) is found, while comparison with the proton-impact cross sections of Van den Bos (1969) suggests that the 2s–2p dipole coupling is more sensitive to the choice of the 2 ^{1}S helium wave function than is the Born 1s–2s short-range coupling. The inclusion of wavelength distortion, back-couplings, 2p–2s couplings, and rotational coupling between the magnetic substates affects the proton-impact excitations more than it does the electron-impact excitations. (auth) (UK)

23786 TRANSITIONS IN THE SUBLEVELS OF THE FINE STRUCTURE OF HYDROGEN. Chibisov, M. I. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 4-7(Jul 1969).

Translated from Opt. Spektrosk.; 27: 9-16(Jul 1969).

A calculation of the cross sections for the transitions between the sublevels of the n = 2 state of hydrogen due to collisions between charged particles and neutral hydrogen atoms in the ground state is presented. The system of three Schroedinger equations describing the interaction of the hydrogen atom with the charge was solved exactly, using the adiabatic approximation. (auth)

23787 CLASSICAL CALCULATION OF THE IONIZATION CROSS SECTIONS OF ALKALI METALS BY ELECTRONS AT LOW ENERGIES. Stern, Bernard (Observatoire de Paris, Meudon, France). Compt. Rend., Ser. B; 270: 533-6(23 Feb 1970). (In French).

The model proposed by Burgess is used to calculate the ionization cross sections of Li, Na, and K by electrons for energies up to 40 eV. In each case the cross section is evaluated by assuming that the kinetic energy of the target electron is equal to the energy associated with the atomic orbital in the self-consistent field, then a mean value is calculated with the help of the probability density in the impulse space corresponding to this atomic orbital. The values obtained are compared with classical theoretical ones and with experimental data. (France)

23788 BOUND-STATE EFFECTS IN ATOMIC REARRANGEMENT COLLISIONS. Joachain, C. J. (Univ. Libre, Brussels); Van Den Eynde, R. K. Physica; 46: 8-16(23 Feb 1970).

The influence of target structure effects in atomic rearrangement collisions is investigated. This bound-state problem is studied for two simple reactions: excitation of the 2^3S state of helium from the ground state by high-energy electron impact and charge transfer of fast protons on helium. (auth)

23789 UNIQUENESS OF SOLUTIONS OF THE CLOSE-COUPLING EQUATIONS FOR ELECTRON SCATTERING. Norcross, D. W. (University Coll., London). J. Phys., B (London); 2: 1300-3(Dec 1969).

Instabilities observed in solutions of the close-coupling equations are eliminated by removing a lack of uniqueness in the radial solutions. Improved results are obtained for the case of Be^+ elastic scattering. (auth) (UK)

23790 AN APPLICATION OF THE POLARIZED-ORBITAL APPROXIMATION TO ELECTRON IMPACT EXCITATION OF ATOMIC HYDROGEN. Lloyd, M. D.; McDowell, M. R. C. (Univ. of Durham, Eng.). J. Phys., B (London); 2: 1313-22(Dec 1969).

Two approximations for electron-impact excitation of atomic hydrogen are discussed. Both include polarization effects to first

order. In the first (A), a polarized Born approximation, the unperturbed ground-state target eigenfunction is replaced in the direct term of the scattering amplitude by a perturbed first-order function. The second approximation treated (B) consists of replacing the incident plane wave appropriate to Born's approximation by polarized orbitals for the incident electron. Calculations are carried out in both models, for the 1s → 2s and 1s → 2p transitions. In all cases the calculated cross sections lie below the corresponding born approximation and approach it at high impact energies. In the case of approximation (B), when nonadiabatic effects are included in determining the polarized orbitals, the calculated cross sections are in good agreement with experiment near threshold (but do not give the detailed resonance structure). (auth) (UK)

23791 BORN CROSS SECTIONS FOR THE IONIZATION OF He AND Li^+ BY ELECTRON IMPACT. Economides, D. G.; McDowell, M. R. C. (Univ. of Durham, Eng.). J. Phys., B (London); 2: 1323-31(Dec 1969).

First Born approximation cross sections are calculated for the ionization of the ground states of He and Li^+ by electron impact, in the energy range from threshold to 9 keV. An open-shell two-parameter wave function is used for the ground state of the target. A partial wave expansion is used for the ejected electron, the radial functions being continuum Hartree–Fock or Sloan polarized orbitals. The partial wave sums converge to within 0.1% of the total by $l = 4$. The calculations were carried out using both the length and velocity formulations of the Born approximation. The length results are approximately 9% higher than the velocity results for He and 6% higher for Li^+. The cross sections obtained are in excellent agreement with experiment at energies in excess of twenty-five times threshold and approach the Bethe limit (within 3%) at energies in excess of fifty times threshold. (auth) (UK)

23792 THE RANGES OF VALIDITY OF THE BORN AND BETHE APPROXIMATIONS FOR THE SINGLE IONIZATION OF He^+ AND Li^+ IONS BY ELECTRON IMPACT. Peart, B.; Walton, D. S.; Dolder, K. T. (Univ. of Newcastle-upon-Tyne, Eng.). J. Phys., B (London); 2: 1347-52(Dec 1969).

Absolute measurements were made of cross sections for the single ionization of He^+ ions by electrons with energies from threshold (54.4 eV) to 10 keV. The results are in good agreement with those of an earlier experiment by Dolder et al. (1961), which was confined to energies below 1 keV. Cross sections for the single ionization of Li^+ were also measured for electron energies between 3 and 25 keV. Comparison of these results with calculations (performed elsewhere) based on the Born and Bethe approximations shows that, for both ions, the former approximation gives results in excellent agreement with the experiments when the electron energies exceed twenty times threshold, whilst the Bethe approximation is only valid for energies greater than about 50 times threshold. (auth) (UK)

23793 ON THE REACTION $He^+ + Ar \rightarrow He + (Ar^{2+})^*$ AT LOW ENERGIES. Champion, R. L.; Doverspike, L. D. (Coll. of William and Mary, Williamsburg, Va.). J. Phys., B (London); 2: 1353-6(Dec 1969).

Kinematic studies of the collision system $He^+ + Ar$ at low collision energies confirmed that the charge-transfer process $He^+ + Ar \rightarrow Ar^+ + He$ is highly endothermic and can involve large momentum transfer. Ar^{2+} ions are also produced and, over the range of collision energies investigated, the cross section for production of Ar^{2+} is approximately 20% of that for Ar^+ formation. (auth) (UK)

23794 COLLISIONAL QUENCHING OF METASTABLE HYDROGEN. Dose, V.; Meyer, V.; Salzmann, M. (Univ., Zurich). J. Phys., B (London); 2: 1357-65(Dec 1969).

Absolute total cross sections for collisional destruction of metastable hydrogen H(2S) in collisions with argon, nitrogen, and water vapour were measured for energies between 2 and 60 keV. Low-energy data were also obtained for metastable deuterium. For all three target gases the cross sections rise from about 0.5×10^{-15} cm^2 at 60 keV to 2.5×10^{-15} cm^2 at 2 keV. Special attention was paid to the precise determination of the target gas pressure and the effective target length. The procedure is discussed in some detail. As the results of this work are absolute, they may be of some interest in connection with the design and operation of polarized negative hydrogen ion sources. (auth) (UK)

23795 FREDHOLM METHOD. I. A NUMERICAL PROCEDURE FOR ELASTIC SCATTERING. Reinhardt, William P.; Szabo, Attila (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 1: 1162-9(Apr 1970).

The Fredholm expansion of the determinant whose phase gives the elastic-scattering phase shift is "summed" by use of numerical quadrature, reducing the calculation of the phase shift to evaluation of a single finite-dimensional determinant. The method is essentially exact and is applicable, without modification, to nonlocal potentials. Results for the low-energy static and static-exchange scattering of electrons from hydrogen atoms are presented as a simple illustration of the method. (auth)

23796 ELECTRONIC TRANSITIONS IN SLOW COLLISIONS OF ATOMS AND MOLECULES. III. EIKONAL APPROXIMATION FOR NONCLASSICAL SCATTERING. Chen, Joseph C. Y. (Univ. of California, San Diego, La Jolla); Wang, Chen-show; Watson, Kenneth M. Phys. Rev., A; 1: 1150-62(Apr 1970).

Characteristic quantum features in atomic collisions are analyzed in the eikonal approximations. Numerical illustrations are given for the (He^+,He) system, using a set of model potentials that provide a reasonable description of the interaction between the ground states of He^+ and He in the quasi-adiabatic (diabatic) limit. (auth)

23797 COULOMB T MATRIX AND ELECTRON CAPTURE BY PROTONS PASSING THROUGH HYDROGEN. Shastry, C. S.; Kumar, L.; Callaway, J. (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 1: 1137-43(Apr 1970).

Using Nutt's expression for the two-particle off-shell Coulomb T matrix, and neglecting multiple-scattering terms in Faddeev's expansion for the transition matrix, an expression for the charge-exchange amplitude in proton–hydrogen scattering is derived. The results of numerical calculations are compared with the corresponding results of Brinkman and Kramers, of Jackson and Schiff, and of Drisko. An analytical expression for the total cross section at high energies is obtained from this formalism. In the high-energy limit, the results approach the Brinkman–Kramers formula. (auth)

23798 TOTAL CROSS SECTIONS FOR INELASTIC SCATTERING OF CHARGED PARTICLES BY ATOMS AND MOLECULES. IV. POSITIVE LITHIUM ION. Kim, Yong-ki; Inokuti, Mitio (Argonne National Lab., Ill.). Phys. Rev., A; 1: 1132-7(Apr 1970).

The Born cross sections for several important discrete excitations of Li^+ from its ground state were calculated with correlated wave functions. By extrapolation, cross sections for higher excitations were also determined. Subtraction of the sum σ_{ex} of these excitation cross sections from the total inelastic-scattering cross section σ_{tot} obtained through a sum rule for the Bethe cross sections yields a reliable "counting" ionization cross section σ_i. The cross sections thus obtained are $\sigma_{tot} = (z/\beta)^2(0.536\{\ln[\beta^2/(1-\beta^2)] - \beta^2\} + 5.216 \pm 0.002) \times 10^{-20}$ cm^2, $\sigma_{ex} = (z/\beta)^2(0.265\{\ln[\beta^2/(1-\beta^2)] - \beta^2\} + 2.295 \pm 0.002) \times 10^{-20}$ cm^2, and $\sigma_i = (z/\beta^2(0.271\{\ln[\beta^2/(1-\beta^2)] - \beta^2\} + 2.921 \pm 0.004) \times 10^{-20}$ cm^2, where ze is the charge of the incident particle and β is its velocity divided by that of light. The ionization cross section is in excellent agreement with experimental data in the asymptotic region (incident electron energy $\gtrsim$ 5 keV). (auth)

23799 CROSS-SECTION RATIOS FOR K* + Rb ELECTRONIC EXCITATION TRANSFER. Stacey, V.; Zare, R. N. (Univ. of Colorado, Boulder). Phys. Rev., A; 1: 1125-31(Apr 1970).

Cross-section ratios were determined for the collisional transfer of electronic energy from the resonance levels of K to those of Rb. Possibilities of systematic errors are discussed. Combined with the absolute cross sections of Ornstein and Zare, these ratios give a complete set of cross-section values, namely, $Q(K^2P_{\frac{3}{2}} \rightarrow Rb^2P_{\frac{3}{2}}) = 2.3 \pm 0.6$ Å^2, $Q(K^2P_{\frac{1}{2}} \rightarrow Rb^2P_{\frac{3}{2}}) = 5.3 \pm 0.8$ Å^2, $Q(K^2P_{\frac{3}{2}} \rightarrow Rb^2P_{\frac{1}{2}}) = 2.5 \pm 0.5$ Å^2, and $Q(K^2P_{\frac{1}{2}} \rightarrow Rb^2P_{\frac{1}{2}}) = 5.5 \pm 1.2$ Å^2. (auth)

23800 EQUILIBRIUM CHARGE FRACTIONS OF ALUMINUM IONS IN NITROGEN FROM 0.4 TO 4.0 MeV. Ryding, G. (High Voltage Engineering Corp., Burlington, Mass.); Wittkower, A.; Nussbaum, G. H.; Saxman, A. C.; Bastide, R.; Kessel, Q.; Rose, P. H. Phys. Rev., A; 1: 1081-2(Apr 1970).

Equilibrium charge fractions were measured for aluminum ions at energies from 0.4 to 4.0 MeV passing through nitrogen gas. Charge states from 0 to 7+ were observed. The mean charge increased from 1.47 at 0.4 MeV to 3.84 at 4.0 MeV. (auth)

23801 COINCIDENCE MEASUREMENTS OF CLOSE H^+-ON-He COLLISIONS. Keever, William; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev., A; 1: 1083-5(Apr 1970).

Differential measurements were made for close encounters of protons with helium atoms, measuring the charge state after collision of both particles in coincidence. Incident proton energies ranged from 5 to 170 keV and the scattering angle was 10°. The probabilities versus energies of three reactions were studied: electron transfer P_{01}, scattering without change of charge of either particle P_{10}, and ionization of the target (so that both particles are singly ionized after the collision) P_{11}. Here P_{01} was found to exhibit a damped resonant structure plotted versus energy and P_{10} shows a complementary oscillatory structure. The ionization probability P_{11} increased smoothly with energy. (auth)

23802 POLARIZATION OF LYMAN-α RADIATION EMITTED IN ELECTRON COLLISIONS WITH HYDROGEN ATOMS AND MOLECULES. Ott, W. R.; Kauppila, W. E.; Fite, W. L. (Univ. of Pittsburgh). Phys. Rev., A; 1: 1089-98(Apr 1970).

The polarizations of Lyman-α radiation produced (1) by electron impact on atomic and molecular hydrogen and (2) by electric field quenching of metastable 2S hydrogen atoms were measured. The polarization analyzer was a LiF crystal set at the Brewster angle, with reflected radiation being detected by an iodine-vapor photon counter. Generally good agreement between the measured polarization fractions and recent theoretical predictions was found. The radiation produced by quenching metastable atoms in an electric field was found to be polarized with a polarization fraction of −0.30 ± 0.02, which compares with the theoretical value −0.323. (auth)

23803 EXCITATION OF ATOMIC HYDROGEN TO THE METASTABLE $2^2S_{\frac{1}{2}}$ STATE BY ELECTRON IMPACT. Kauppila, W. E.; Ott, W. R.; Fite, W. L. (Univ. of Pittsburg). Phys. Rev., A; 1: 1099-1108(Apr 1970).

The cross section for excitation of atomic hydrogen to the $2^2S_{\frac{1}{2}}$ state by electron impact was remeasured in a modulated-crossed-beam experiment in the energy range extending from threshold to 1000 eV. Absolute values for the 2S cross section were obtained by measuring the ratio of the 2S to 2P cross sections and using previous measurements of the 2P cross section, which were normalized to the Born approximation at high energies. The atoms excited to the 2P and 2S states were detected by observing the Lyman-α photons produced by radiative decay and by quenching in an electrostatic field, respectively. In order to determine the total cross section, it was necessary to consider the polarization of the Lyman-α radiation emitted in each method of detection. The remeasured cross section is found to be in agreement with the Born approximation above 200 eV. The measured ratios are in reasonable agreement with the ratios that would be predicted by the close-coupling theory of Burke et al. The peak value of the cross-section curve is $0.168 \pm 0.020\pi a_0^2$, and occurs at 11.6 ± 0.2 eV. (auth)

23804 STABILIZATION METHOD OF CALCULATING RESONANCE ENERGIES: MODEL PROBLEM. Hazi, Andrew U. (Univ. of California, Los Angeles); Taylor, Howard S. Phys. Rev., A; 1: 1109-20(Apr 1970).

The stabilization method of calculating resonance energies is applied to the elastic scattering from a one-dimensional model potential containing a barrier. For sufficiently large basis sets, the stabilization method yields good approximations to the inner part of the exact scattering wave functions at energies equal to the eigenvalues of the truncated matrix of the Hamiltonian in both the resonant and nonresonant energy regions. Good approximations are calculated to the exact phase shifts from the square-integrable wave functions produced by the stabilization method. A simple model is derived to explain the behavior of the eigenvalues as a function of the size of the basis. The degree of stability of the eigenvalues approximating the resonance energy is proportional to the width of the resonance. Both the energy and the width of the resonance can be calculated from the change in the stable eigenvalue as the size of the basis increases. (auth)

23805 INTERPRETATION OF INTERFERENCE STRUCTURE IN ELASTIC SCATTERING USING THE SEMICLASSICAL ACTION. Pritchard, David E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., A; 1: 1120-4(Apr 1970).

Interpretation of the Ford–Wheeler semiclassical expression for the scattering amplitude as an integral, over both positive and negative impact parameters, of a quantity depending on the action is described. This formulation clarifies the relationship between the action and the phase of the semiclassical expression for the scattering amplitude. Using this formulation, it is shown that interference processes in both one- and two-channel elastic scattering are analogous to those occurring in the two-slit diffraction of light. (auth)

23806 CONTINUUM PROCESSES INVOLVING ATOMIC SYSTEMS WITH CONFIGURATIONS $1s^2 \ldots 3p^q$. Conneely, M. J.; Smith, K.; Lipsky, L. (Univ. of Nebraska, Lincoln). J. Phys., B (London); 3: 493-512(Apr 1970).

The close-coupling approximation has been used to compute cross sections for a wide range of processes (electron impact, photodetachment, and photoionization) involving atomic systems with incomplete outer 3p subshells. The processes have been chosen for their astrophysical interest. The purpose of the investigation is to provide a unified theoretical model for the wide variety of processes investigated and to compare the predictions of this close-coupling approach with previous theoretical approximations and experiment. The principal conclusions are that these calculations are in reasonable agreement with observed photoionization cross sections where available, but differ somewhat from previous calculations. Of particular interest is the predicted absence of an expected resonance series in both the $^1S^e$ and $^1D^e$ partialwave contributions to the photoionization of sulphur as well as the absence of shape resonances in silicon and phosphorus analogous to those recently reported in carbon and nitrogen. (auth) (UK)

23807 EXCHANGE EFFECTS IN LOW-ENERGY ELECTRON SCATTERING. Fink, M. (Univ. of Texas, Austin); Ingram, J. C.; Yates, A. C. J. Phys., B (London); 3: 536-8(Apr 1970).

The differential cross section and spin polarization for 300 eV electrons scattered from bismuth were calculated employing Kohn and Sham's (1965) approximation for exchange effects. The results show the same 2 to 3° shift in the scattering pattern observed in less approximate treatments of exchange effects and are in agreement with experiment. (auth) (UK)

23808 CHARGE TRANSFER AND FINE-STRUCTURE TRANSITIONS IN $Ar^+(^2P_j) + Ar(^1S_0)$ COLLISIONS. Johnson, R. E. (Queen's Univ., Belfast). J. Phys., B (London); 3: 539-51(Apr 1970).

Cross sections for charge transfer and fine-structure transitions within the ^2P multiplet were calculated for the $Ar^+(^2P_j) + Ar(^1S_0)$ collision using the atomic eigenfunction expansion in the impact-parameter method and neglecting momentum transfer. Formulae for the exchange energies, valid at large internuclear separations, were obtained for the Σ and Π states, and the spin–orbit effects were included as an energy defect. The six coupled equations, with and without rotational coupling, were solved numerically for those energies at which the velocity of the incident ion is comparable to the fine-structure splitting in atomic units, and the resulting transition probabilities were integrated approximately. It is found that the two fine-structure states $j = \frac{1}{2}$, $j = \frac{3}{2}$ undergo charge transfer with near-equal efficiency and have, to this order, the usual symmetric resonance behaviour. Further, the spin-change cross sections are significantly affected by the inclusion of rotational coupling. (auth) (UK)

23809 PARTICLE–ATOM INTERACTION POTENTIAL FOR LOW-ENERGY SCATTERING. Malinowski, S. (Univ. of Lodz, Poland). Acta Phys. Pol.; A37: 397-403(1970).

A method is presented, which permits the particle–atom interaction potential to be found for arbitrary particle-to-atom distance. For $r' \to \infty$ the method gives the well-known expression for the interaction potential. The correction term $(2/\mu)\beta_4((Z')^2/r'^6)$ resulting from this method is just the zeroth-order adiabatic correction resulting from the relative motion: atom–scattered-particle. It thus seems reasonable to call this correction a zeroth-order correction for the atom–scattered-particle motion or a velocity-dependent dynamical correction whereas it should not be called a nonadiabatic correction. (auth)

23810 EXCITATION OF HELIUM BY H_1^+, H_2^+, AND H_3^+ AT MEDIUM ENERGIES. Grouard, Jean-Pierre; de Palmas, Henri (Laboratoire de Physique et Optique Corpusculaires, Paris). Compt. Rend., Ser. B; 269: 1234-7(15 Dec 1969). (In French).

A measurement is made of the cross sections relative to the excitation of the 4 ^1D level of helium by H_1^+, H_2^+, H_3^+ in the energy range 15 to 40 keV. (tr-auth)

23811 ANGULAR CORRELATION OF SCATTERED AND EJECTED ELECTRONS IN IONIZING COLLISIONS. Vriens, L. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 45: 400-6(15 Dec 1969).

Angular distributions of ejected electrons, recently measured by Ehrhardt et al. in coincidence with the scattered electrons, were found to consist of two distinct peaks. The Born approximation is used to discuss the nature of these peaks for the related case of fast incident electrons. Qualitative explanations are given for some of the characteristic features of the angular distributions, for example for the shift of the measured symmetry axis of the peaks towards larger angles for small electron energies. (auth)

23812 MOLECULAR COLLISIONS. XI. Curtiss, C. F. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 52: 1078-81 (1 Feb 1970).

The development of Paper VIII of the series is continued to obtain equations and expressions suitable for the numerical evaluation of the cross sections for rotational excitation in collisions of rigid diatomic molecules interacting through an arbitrary soft potential. Explicit equations that describe collisions between an atom and a diatomic molecule are also given. An approximate solution of the equations is discussed. (auth)

23813 ABSOLUTE DIFFERENTIAL CROSS SECTIONS OF ELASTICALLY SCATTERED ELECTRONS. III. CO AND N_2 AT

500, 400, AND 300 eV. Bromberg, J. Philip (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 52: 1243-8(1 Feb 1970).

Absolute differential cross sections of electrons elastically scattered by CO and N_2 were measured at 500, 400, and 300 eV. At scattering angles greater than 12° there is no significant difference between the two isoelectronic molecules. At small angles the cross sections for CO increase at a slightly faster rate than for N_2, reflecting the presence of a dipole moment for the heteronuclear CO molecule. (auth)

23814 ROTATION-TRANSLATION ENERGY TRANSFER BETWEEN INDIVIDUAL QUANTUM STATES OF HD($B\ ^1\Sigma_u^+$). Akins, Daniel L.; Fink, Ewald H.; Moore, C. Bradley (Univ. of California, Berkeley). J. Chem. Phys.; 52: 1604-5(1 Feb 1970).

Collisions of electronically excited HD molecules with HD, ^{3}He, ^{4}He, Ne, and D_2 were studied. The resulting rotational energy transfer cross sections are tabulated. It is concluded that the total energy transfer probabilities are large. The cross sections for rotational energy transfer decrease with increasing mass of the rare gas collision partner. A distinct difference between the spherical collision partners ^{3}He and ^{4}He vs the nonspherical collision partners HD and D_2 was found. Processes that violate the optical selection rule $\Delta J = \pm 1$ were observed. (A.G.W.)

23815 CLASSICAL INELASTIC COLLISION CROSS SECTIONS FOR LOADED SPHERES. Miles, John R. N.; Dahler, John S. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 52: 1292-1301(1 Feb 1970).

Formal expressions are given for the transition rates and related cross sections appropriate to collisions between molecules with internal degrees of freedom whose initial and final states are specified in varying degrees of detail. The formalism is specialized to the case of rigid-body collisions between spherical and loaded spherical molecules. The simplicity of the collision dynamics for this system enables an exact expression to be found for the basic cross section $\sigma(L', c' \rightarrow L, c)$ for scattering from a beam of specified velocity c′ and angular momentum L′ to a state of velocity c and angular momentum L. Experimentally observable cross sections such as $\sigma(c', |L'| \rightarrow c, |L|)$ and $\sigma_{total}(|L| \rightarrow |L'|)$ can be obtained by numerical integration of the basic cross section. Numerical values for these cross sections are calculated for the case of excitations from the "ground state" ($L' = 0$) for HD–He and HT–He collisions. The total cross sections for these collisional pairs are found to be $0.92\pi R^2$ and $0.86\pi R^2$, respectively, where πR^2 is the rigid-sphere cross section. (auth)

23816 ISOTOPE EFFECT AS A FUNCTION OF ALPHA-PARTICLE ENERGY IN THE IONIZATION OF HYDROCARBON GASES. Jesse, William P. (St. Procopius Coll., Lisle, Ill.). J. Chem. Phys.; 52: 1314-16(1 Feb 1970).

The isotope ratio, i.e., the ratio of the ionization produced by a given alpha particle in a deuterated hydrocarbon gas to the corresponding ionization in an undeuterated hydrocarbon gas, was investigated as a function of alpha-particle energies in the range 5.8 to 1.6 MeV. Alpha particles from ^{244}Cm, ^{210}Po, and ^{147}Sm were employed. Particles having reduced energies were also obtained by passing alpha particles through thin mica windows. The isotope effect was larger in the hydrocarbons investigated than in previous experiments for ionization by beta particles from ^{63}Ni. For the hydrocarbons methane, ethane, acetylene, and ethylene there was found to be a very small increase of the order of 1% to 3% in the isotope ratio as one decreased the alpha-particle energy from 5 to 1.6 MeV. A tentative explanation of this change with alpha energy has been advanced. (auth)

23817 ASYMPTOTIC EVALUATION OF WKB MATRIX ELEMENTS. II. USE OF LANGER'S UNIFORM ASYMPTOTIC WAVE FUNCTIONS. Smith, Wesley D.; Pack, Russell T. (Brigham Young Univ., Provo, Utah). J. Chem. Phys.; 52: 1381-6(1 Feb 1970).

An improvement in a previous procedure for the analytic asymptotic evaluation of integrals arising in the quantum-mechanical theory of inelastic molecular collisions is presented. The integrals are evaluated using Langer's uniform asymptotic wave functions and the higher-order saddle-point or steepest-descents method. It is found that the Langer functions give no better results than WKB functions, but the higher-order steepest-descents corrections produce a marked improvement. The result is a simple method for evaluating a large class of integrals with an error of 0.1% to 2.1%. (auth)

Atomic Theory

23818 CORRELATION ENERGY OF ATOMIC SYSTEMS. Safronova, U. I.; Ivanova, A. N. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 103-5(Aug 1969).

Translated from Opt. Spektrosk.; 27: 193-7(Aug 1969).

The correlation energy of atomic systems was determined using the formula $E^{corr} = E_{total} - E^{HF}$. The total and Hartree–Fock energies are represented as power series in $1/Z$. As a result, the correlation energy was found to be $E_2^{corr} = \Delta E_1^{corr} Z + \Delta E_2^{corr}$. (auth)

23819 HARTREE–FOCK THEORY FOR BOUND STATES AND CONTINUUM STATES. II. CONTINUUM STATES. Seaton, M. J. (University Coll., London). Comments At. Mol. Phys.; 1: 184-8 (Feb-Mar 1970).

The differences between the variational principles for bound states and continuum states are reviewed. The various approximate forms that may be used for the wave functions for continuum states are discussed. (A.G.W.)

23820 HARTREE–FOCK THEORY FOR BOUND STATES AND CONTINUUM STATES. I. BOUND STATES. Seaton, M. J. (University Coll., London). Comments At. Mol. Phys.; 1: 177-83(Feb-Mar 1970).

A review of the variational principle is followed by a discussion of the question of choosing a functional form for bound states. It is then shown that the unrestricted Hartree–Fock theory is a special case of configuration-interaction theory. Different approaches to configuration-interaction theory are considered briefly. (A.G.W.)

23821 SOME APPLICATIONS OF CSAVINSKYS' SOLUTION OF THE T–F EQUATION. Kumar, Satish; Jain, Ashok (Delhi Univ.). J. Phys. Soc. Jap.; 28: 1046-51(Apr 1970).

A recent variational solution of the Thomas–Fermi equation for atoms given by Csavinszky is used to calculate certain physical quantities analytically. The results are compared with those obtained on the basis of the unmodified TF model and the Tietz approximation. It is shown that Csavinszky's solution—in which the density has the right behavior at large distances—leads to substantial improvement over the usual TF results. (auth)

23822 QUANTUM MECHANICAL INTERFERENCE IN ATOMIC PHYSICS. Kim, Yong-ki (Argonne National Lab., Ill.). New Phys. (S. Korea), Suppl.; 9: No. 1, 3-6(Nov 1967).

Minima in the cross sections for photoabsorption and also for the inelastic scattering of fast electrons by atoms are discussed as examples of quantum mechanical interference. (auth)

23823 ELECTRIC DIPOLE POLARIZABILITY OF ATOMS BY THE HARTREE–FOCK–ROOTHAAN METHOD. THEORY FOR OPEN-SHELL SYSTEMS. Malinowski, S. (Univ. of Lodz, Poland). Acta Phys. Pol.; A37: 357-64(1970).

A method for calculating the dipole polarizabilities of open-shell systems is presented. This method requires finding the Hartree–Fock–Roothaan wave functions for atoms in a perturbing field. The atomic orbitals are expressed as linear combinations of Slater-type functions. The classical polarizability is calculated as the limiting value of $\alpha = \mu(F)/F$ when $F \rightarrow 0$, where F is the strength of the external electric field, and $\mu(F)$ is the induced dipole moment. (auth)

23824 ATOMIC RESONANCES FROM A MANY-BODY POINT OF VIEW. I. Wendin, G. (Inst. of Theoretical Physics, Goteborg). J. Phys., B (London); 3: 455-65(Apr 1970).

Photoabsorption in atoms is analysed in terms of the diagram expansion for the polarization propagator. Basis wave functions calculated in an effective Hartree–Fock potential are used. Without approximations the Fano formula for autoionizing resonances is derived. The line shape parameters are expressed in terms of reducible (screened) quantities like the self-energy, the generalized dipole matrix element, and the background polarizability. The parameters can be expanded in perturbation series involving the infinite set of channels that forms the excitation spectrum for the atomic system. A small number of channels is usually sufficient for describing the properties of the resonances and the underlying continuum. For these channels, however, one cannot in general neglect polarization effects. Therefore the perturbation expansions for the line shape parameters have to be taken to high or infinite order. In a following paper the effect of screening will be discussed and applied to rare-gas atoms. (auth) (UK)

23825 ATOMIC RESONANCES FROM A MANY-BODY POINT OF VIEW. II. Wendin, G. (Inst. of Theoretical Physics, Goteborg). J. Phys., B (London); 3: 466-77(Apr 1970).

In a previous paper the Fano formula with generalized parameters using many-body perturbation theory was derived. In this paper the theory, in the lowest order, is applied to helium. For the 2s2p ^{1}P resonance a rough estimate gives a value for the (dynamical) dipole matrix element within twenty per cent of the experimental value and with a correct sign. For many-electron

atomic systems polarization effects become important. The effect of screening is demonstrated using a random phase approximation for the continuum from a single shell. The polarization effects are studied in the ns^2np^6 shells of Ne, Ar, Kr, and Xe (n = 2, 3, 4, 5 respectively). A simple explanation is found for the experimental fact that the (ns; (n + 1)p) ^1P resonance for Ne is strongly asymmetric (q = −1, 6) while for Ar, Kr, and Xe it has the characteristic of an absorption window with $|q| \ll 1$. (auth) (UK)

23826 LINEAR CONSTRAINED VARIATIONAL PROCEDURE FOR LCAO–SCF WAVE FUNCTIONS. Weber, Thomas A. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 52: 1498-1500(1 Feb 1970).

A variational procedure is developed for the determination of LCAO–SCF wave functions subjected to a set of linear constraints. The procedure gives wave functions from the solution of an eigenvector-type problem using a self-consistent iterative technique. (auth)

23827 SELF-CONSISTENT-FIELD ATOMIC WAVE FUNCTIONS FROM EFFICIENT NESTED BASIS SETS. Weber, Thomas A.; Handy, Nicholas C.; Parr, Robert G. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 52: 1501-7(1 Feb 1970).

Constrained self-consistent-field wave functions are reported for the ground-state neutral atoms, He to Ne, in which each atomic orbital is a linear combination of Slater-type orbitals. A more efficient use of the basis set chosen reduces the number of parameters to be optimized while maintaining the energy equal to within five significant figures to the energy of the fully optimized basis set. The reduction in the number of independent linear and nonlinear parameters is achieved by forcing a certain long-range behavior and a nuclear cusp condition. In one set of calculations the orbitals are forced to behave asymptotically as $\phi_i \sim \exp[-r(-2\epsilon_i)^{\frac{1}{2}}]$, where ϵ_i is the orbital energy. In the second set of calculations, the orbitals are also forced to exactly obey the nuclear cusp condition. (auth)

23828 NATURE OF TWO-PARTICLE CORRELATIONS IN ATOMS: CALCULATION OF MASS POLARIZATION IN THE TWO-ELECTRON ATOM FOR LARGE NUCLEAR CHARGE. Ruffa, A. R. (Naval Research Lab., Washington, D. C.). J. Chem. Phys.; 52: 1512-20(1 Feb 1970).

The nature of two-particle correlations in atoms is examined within the framework of a formalism developed earlier, which involves sum rules for one-particle transitions. Relations for the expectation values of certain two-particle operators derived with the aid of this formalism are shown to be exactly valid for the two-electron atom in the limit of large nuclear charge Z. Similar relations are derived for a more general class of two-particle operators, and these relations are used in a term-by-term evaluation of the series representation of the expectation value of the two-electron repulsion potential $1/r_{12}$. The terms in the series that are zero in the Hartree–Fock approximation are expressed, with the aid of these relations, in terms of the expectation value of the mass-polarization operator $p_1 \cdot p_2$ and the energy. In this way, with the aid of the expression for the correlation energy as a function of Z, one obtains an expression for the mass polarization in the two-electron atom as a function of Z. Comparison of the values for the mass polarization obtained in this way with those calculated by Hart and Herzberg by means of very accurate 20-term variational wave functions shows an agreement that improves with increasing values of Z. The difference for Z = 12 is only about 4%. The results of the calculation are used to draw some inferences concerning the nature of two-particle correlations in atoms. (auth)

Cosmic Radiation

Refer also to abstracts 23643, 23727, 23859, 24207, 24234, and 24379.

23829 (CONF-690814–9) PROPAGATION OF VERY HEAVY PRIMARY COSMIC RAY PARTICLES. Mewaldt, R. A.; Turner, R. E.; Friedlander, M. W.; Israel, M. H. (Washington Univ., St. Louis, Mo. Lab. for Space Physics). [1969]. 8p.

From 11th International Conference on Cosmic Rays, Budapest, Hungary.

Very heavy particles (Z > 75) in primary cosmic radiation are discussed in terms of information which may be derived regarding sources and propagation. Attention is confined to relativistic particles. (W.D.M.)

23830 (NP-18174) STUDY OF THE THRESHOLD RIGIDITY OF COSMIC RADIATION IN A MAGNETOSPHERE MODEL. Jimenez Guzman, Jaime (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1969. 153p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The general aspects of the movement of particles in magnetic fields and a broader definition of threshold rigidity are described. The concept of magnetically quiet times is introduced. The threshold rigidity is studied with models which do not take into account the external sources of the field. The external sources included in the magnetospheric model used for the calculation of the threshold rigidity are then studied. The Mead–Williams model used in the computer is introduced and the method used is described in detail. The method used is the simulation of trajectories with numerical integration base. The results obtained are evaluated. (tr-auth)

23831 HOMOGENEOUS METAGALACTIC ORIGIN OF COSMIC RAYS. Lal, Siddheshwar; Brunstein, Karl (Univ. of Denver). Astrophys. Space Sci.; 6: 415-19(Mar 1970).

Starting with the hypothesis that cosmic rays are evenly distributed in the metagalaxy, it is shown that the flux of the electron–positron component, which is produced through $\pi-\mu-e$ decays, following the nuclear collisions of the cosmic-ray beam with the intergalactic medium, takes $\leq 4 \times 10^{16}$ sec to reach steady state. The corresponding value of the flux of the positron component and its implications regarding the homogeneous model of the metagalactic origin of cosmic rays are discussed. (auth)

23832 THE COSMIC γ-RAY SPECTRUM FROM SECONDARY PARTICLE PRODUCTION IN COSMIC-RAY INTERACTIONS. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Space Sci.; 6: 377-89(Mar 1970).

The cosmic γ-ray spectrum below 1 GeV arising from cosmic-ray p–p interactions is calculated. Its characteristics are determined by the properties of secondary neutral pion production occurring at accelerator energies. A model is chosen for numerical calculations in which the two dominant modes of neutral pion production at accelerator energies are the production of the $\Delta(1.238)$ isobar and one fireball. The effect of α–p and p–α interactions on the cosmic γ-ray spectrum is also calculated. The final results are given in terms of both differential and integral γ-ray energy spectra. (auth)

23833 STUDY ON THE EXTRATERRESTRIAL MATERIAL AT ANTARCTICA. [PART] I. Shima, Makoto; Yabuki, Hideo. Nankyoku Shiryo; No. 33, 53-64(1968). (In Japanese).

The chemical composition and size distribution of cosmic dust collected in Antarctica are discussed. On the basis of the chemical composition, the cosmic dust is classified into Ni–Fe, Fe, and silicate groups. The glassy material, mainly silica, is believed to be a type of tektite. The annual rate of fall of cosmic dust near Syowa Station is estimated to be 3×10^4 tons per yr. (auth) (Geophys. Abstr.)

23834 STUDY ON THE EXTRATERRESTRIAL MATERIAL IN ANTARCTICA. [PART] II. SEASONAL VARIATION AT SYOWA STATION AND LATITUDE EFFECT ON COSMIC DUST. Shima, Makoto; Yabuki, Hideo; Okada, Akihiko. Nankyoku Shiryo; No. 34, 1-13(1969). (In Japanese).

Measurements of the seasonal variation in accretion of cosmic dust were made at various latitudes (30°N.-67°S.) on board the expedition ship Fuji and at Syowa Station, Antarctica. Preliminary results indicate that the seasonal variation and the variation with latitude are not appreciable in the overall accretion of cosmic dust. (Geophys. Abstr.)

23835 DEPENDENCE OF MUON INTENSITY ON GEOMAGNETIC LATITUDE. Bhattacharyya, D. P. (Presidency Coll., Calcutta). Z. Phys.; 234: 17-22(1970).

The vertical momentum spectrum of cosmic-ray muons was determined by a counter-controlled neon hodoscope in the spectral region (0.2 to 3) BeV/c at geomagnetic latitude 12°N. The observed spectrum agrees satisfactorily with the calculated spectrum of Olbert for muon momentum above 1.8 BeV/c. Below about 1.8 BeV/c, the measured spectrum exceeds slightly the theoretical spectrum of Olbert, calculated for the same geomagnetic latitude. The measured spectrum agrees with the experimental spectrum of Allkofer at 9°N, but is somewhat below the spectrum obtained by Hayman in the low momentum region at 57.5°N. This shows that there exists a latitude dependence of the low-momentum muon spectrum. The estimated integral intensity of muon of momentum $\geq$ 320 MeV/c is found to be 7.3×10^{-3} cm^{-2} sec^{-1} str^{-1}, which agrees with the value of other investigators. (auth)

23836 DYNAMICS OF THE ELEVEN-YEAR MODULATION OF GALACTIC COSMIC RAYS. Wang, J. R. (Univ. of Chicago). Astrophys. J.; 160: 261-81(Apr 1970).

The depth of the modulating region L from the dynamical phase

lag between the changes in cosmic-ray intensity and solar activity near the period of solar maximum activity is derived. The analysis is primarily based on correlations between neutron-monitor intensity and the temperature in the solar corona which is assumed to be represented by the intensity of the 5303 Å coronal line. By comparison with a similar analysis by Simpson and Wang for the time of minimum solar modulation it is concluded that there is an order-of-magnitude change in L in the solar equatorial plane, the solar minimum being 5 to 10 A.U. in 1954 and 1965 and becoming ~50 A.U. at solar maximum of 1957-1960 based on the analysis in the present paper. It is shown from the measurements of nucleonic intensity at the constant altitude of 307 g cm^{-2} as a function of particle magnetic rigidity (carried out by aircraft measurements) that there is an order-of-magnitude change in the modulating parameter η over the past solar cycle. The change in η from ~0.4 GV at solar minimum to ~3.5 GV at solar maximum which is derived is compatible with the order-of-magnitude change in L provided the mean cosmic-ray intensity gradient remains approximately constant in time. Finally, by assuming isotropic diffusion with radial dependence of the diffusion coefficient $k \sim r^b$, it is shown that $b \leq 0.6$ during minimum solar modulation if $L \leq 5$ to 10 A.U. During solar maximum b is likely to be ≥ 0.6 if $L \sim 50$ A.U.; b cannot remain zero over a solar cycle if L changes by an order of magnitude. (auth)

23837 NATURE OF THE PRIMARY COSMIC RADIATION. Powell, C. F. Fiz. Szemle, 20: 28-33(Jan 1970). (In Hungarian).

Recognition of the effect of cosmic rays must be attributed to Coulomb who noted in 1785 that the charge of a metallic sphere in the air slowly leaks away, although he could not identify the reason. The problem was further studied by C. T. R. Wilson and others who investigated the causes of the conductivity of air. During the 1930's Regener carried out experiments with highly sensitive electroscopes developed by Millikan, sent up in unmanned balloons. Millikan was able to show that the attenuation of cosmic rays in the atmosphere cannot be explained if the quanta of the primary radiation have identical energy; assumption of 3 components, with energies in the range of 25, 50, and 150 MeV yields acceptable results. Development of the nuclear-emulsion technique was a great help to cosmic-ray research. Measurement of the charge spectrum of the primary cosmic radiation revealed differences in the distribution of elements on Earth, in the radiation, and in space. Considerable amount of work is carried out on the Z content of the primary spectrum. Exact knowledge of the primary radiation is of great interest to scientists, as it is related to the evolution of stars and particle acceleration processes. One must be careful not to speculate unduly and prematurely on Z values near 110, corresponding to the expected new region of stability. (Historical review article). (TTT)

23838 COSMIC-RAY MUON SPECTRA NEAR 1000 GeV AT LARGE ZENITH ANGLES. Asbury, J. G.; Cooper, W. A.; Voyvodic, L.; Walker, R. J.; Wangler, T. P. (Argonne National Lab., Ill.). Nuovo Cim.; 66B: 169-82(11 Apr 1970).

Measurements were made of the cosmic-ray muon spectra at large zenith angles using an optical-spark-chamber magnetic spectrometer with a maximum detectable momentum estimated to be 830 GeV/c. Absolute values of energy spectra up to 200 GeV were obtained at 75, 80 and 85° zenith angles; differential and integral energy spectra approaching 1000 GeV were evaluated at a zenith angle of 80°. The results are in reasonable agreement with previous magnetic-spectrometer data, and with expected variations in energy and direction for muons arising chiefly from pion sources. No evidence was found for dominant kaon or "X-process" muon sources in the 1000-GeV region. There is also no evidence for any elongation of pion lifetime which would be expected if special relativity broke down at distances less than 10^{-16} cm. (auth)

23839 BUBBLE CHAMBER STUDY OF (10 TO 100) GeV COSMIC-RAY MUONS AT ALL ZENITH ANGLES. Kim, Y. S. (Ohio State Univ., Columbus); Voyvodic, L. Nuovo Cim.; 66B: 183-92(11 Apr 1970).

Cosmic-ray muons were studied by analysis of tracks recorded in a large high-field heavy-liquid bubble chamber. From a sample of 50,000 pictures approximately 2,000 muons with energies above 10 GeV were examined for energy and zenith-angle distributions over the complete range from 0 to 90°. In the vertical direction the integral spectrum up to energies exceeding 100 GeV is consistent with depth intensity data and somewhat higher than observed in unshielded vertical magnetic spectrometers. At other zenith angles the expected variations were found which approach a $\cos^2 \theta$ attenuation for muons in the 10 GeV region, and tend towards a $\sec \theta$ enhancement for muon energies above 100 GeV. (auth)

23840 ATMOSPHERIC IONIZATION PERMITS ANALYSIS OF COSMIC SHOWERS BY THE RADAR METHOD. Galli, M.; Mercer, J. B.; Palumbo, G. G. C. (Univ., Bologna. Consiglio Nazionale delle Ricerche, Rome). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 173-84(Mar 1968). (In Italian).

From 17th Annual Conference of the Italian Geophysical Society, Rome, Italy. See CONF-680332-(Pt.1).

The number of ions produced in the atmosphere at the passage of a cosmic-ray shower of $E_0 = 10^{20}$ eV is calculated. The positive ions last a few minutes in the lower atmosphere. The reflected power, when stricken by a radar wave, is barely detectable. The electrons are calculated to have a mean life of 10^{-3} sec. This figure is too low to give coherent reflection; even though well in agreement with other calculated values, it has never been measured. An effective mean life of one order of magnitude larger could give a very powerful method for detecting extensive air showers. (tr-auth)

23841 ABUNDANCES OF COSMIC-RAY PARTICLES WITH $Z \geq 3$. Fody, S. A.; Friedlander, M. W.; Hasegawa, H.; Klarmann, J.; Wells, W. C. (Washington Univ., St. Louis). Planet. Space Sci.; 18: 265-70(Feb 1970).

Two large stacks of nuclear photographic emulsions were exposed to the primary cosmic radiation on a high-altitude balloon flight over Palestine, Texas, on April 24, 1965, during the period of minimum solar activity. The intensities of the fluxes of the groups of heavy particles having rigidities above about 4.3 GV were found to be: L-nuclei ($3 \leq Z \leq 5$) 2.2 ± 0.4 particles/m^2.ster.sec, M-nuclei ($6 \leq Z \leq 9$) 6.8 ± 0.7 particles/m^2.ster.sec, H-nuclei ($Z \geq 10$) 2.5 ± 0.3 particles/m^2.ster.sec. From these, the L/M ratio is derived as 0.32 ± 0.07. All values refer to the top of the atmosphere, having been extrapolated from the flight altitude of 2.7 g/cm^2. The relative abundances of the elements within the L group have also been estimated. (auth) (UK)

Direct Energy Conversion

Refer also to abstracts 23517 and 24146.

23842 (IAE-1701) CERTAIN PROBLEMS OF THE EFFICIENCY OF POWER PRODUCTION IN MHD GENERATORS WITH A NONEQUILIBRIUM PLASMA. Breev, V. V.; Gubarev, A. V.; Gurashvili, V. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 66p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Power production efficiency problems are discussed for permanent large MHD power installations. There is serious doubt as to the future of such machines with the linear conduction (Faraday) sectioned generator most thoroughly studied, since the efficiency of the station does not exceed 40% using currently feasible field inductions of ~10 tesla, a reactor pressure of ≥500 atm, and a gas temperature of ≤2000°K, which are the technical limits for the next decade. Even under the most optimistic assumptions ($T \simeq 2500$°K, $\beta = 10$ tesla, a high degree of heat regeneration, absence of thermal losses, etc.) for a reactor pressure of ~100 atm, a station efficiency of greater than 50% is achieved for a unit power of the MHD generator of $\geq 3 \times 10^6$ kW. The reason for such low efficiency is that the physical operating principles of the generator envisioned at the present time (ionization of the plasma, etc.) and the electrogasdynamic design of the generator make it impossible to obtain a high efficiency in the energy conversion process itself in the channel. (JPRS)

23843 (INR-1107) HALL-TYPE MHD GENERATOR WITH NONUNIFORM GAS PARAMETERS ALONG THE CHANNEL AXIS. Celinski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 39p. Dep. CFSTI (U. S. Sales Only).

Expressions are derived which enable one to calculate the electrical parameters of the generator when the gas parameters vary along the generator channel. The comparison between the calculated electrical parameters in the case of uniform and nonuniform gas parameters was also performed. (auth)

23844 (JPRS-50142) STATUS AND TRENDS IN THE DEVELOPMENT OF THERMIONIC CONVERTERS. Danilov, Yu. I.; Karetnikov, D. V. Translated from At. Energ. (USSR); 28: 33-7 (Jan 1970). 10p. CFSTI.

International developments in the field of thermionic conversion which came to light in the conferences at Stresa, Italy, and elsewhere are discussed. Several arrangements of thermionic reactors under consideration are described. Progress in electrogenerating elements (emitters), plasma physics, electrode effects, reactor testing, terminology, etc. is reported. (D.L.C.)

23845 (JUL-619-TP) PHYSICAL BASIS OF THE MPD ENERGY TRANSFORMATION WITH SPECIAL ATTENTION TO THE DETERMINATION OF THE PLASMA DYNAMIC CHARACTERIS-

TIC QUANTITY AND MEASUREMENT RESULTS OF THE ARGAS EXPERIMENTAL PLANT. Bohn, T. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). Oct 1969. 137p. (In German). Dep. CFSTI (U. S. Sales Only).

Beginning with the principle and the physical bases of the MPD energy transformation, a series of studies were carried out on a systematic basis. The physics of the four-component plasma are especially considered. The theoretical bases of such a plasma are shown and compared with the measurements carried out in the present study. These basic measurements are related to the determination of the electron collision cross section in collision with the seed material (cesium) and the rare gas atoms (Ar and He) and with ions. The determination of the plasma conductivity was made in dependence on the current density, with consideration of the geometry of the discharge space and the respective loss processes by radiation and ambipolar diffusion. Also of basic interest is the determination of the relaxation behavior of the plasma of an MPD working gas. Measurements made with respect to these made possible the determination of the ionization coefficients in a wide temperature and pressure range under consideration of the effect of an external magnetic field. All these measurements for the determination of the static and dynamic behavior of the plasma of an MPD working gas were made in order to understand better the measurement results on the research installation ARGAS. They were necessary as no available measurement values existed. The research installation ARGAS, the largest of its type at the present time, yielded a series of measurements that are represented in a compiled form. Of especial significance are the measurements with respect to the nonequilibrium ionization caused by the magnetically induced electric field and the related plasma stabilities. The results obtained with ARGAS are of basic significance not only in the physics of MPD energy transformation but in future technology and economy of MPD nuclear power plants. (tr-auth)

23846 COMMERCIAL THERMOELECTRIC GENERATOR APPLICATIONS AND ECONOMIC CONSIDERATIONS. Rubinstein, M. A. (General Instrument Corp., Newark, N. J.). Energy Convers.; 9: 123-9(Dec 1969).

Presented at Intersociety Energy Conversion Engineering Conference, Aug. 1968, Boulder, Colorado. A brief description is given of available commercial thermoelectric generators and of the materials and heat sources used. A brief analysis is also made of the economics of such generators in relation to other competitive power sources, such as batteries and small MG sets. The inherent reliability and low maintenance requirements of TEGs is emphasised and applications in actual use are described, together with relevant operational and performance characteristics. (UK)

23847 OPEN- AND SHORT-CIRCUIT EXPERIMENTS WITH A NONEQUILIBRIUM MHD GENERATOR USING BOTH COLD AND HOT INSULATOR WALLS. Reilly, J. P. (Avco Everett Research Lab., Everett, Mass.). Energy Convers.; 10: 13-23(Mar 1970).

Experiments were performed in a supersonic MHD channel using helium seeded with cesium. Measurements were made of axial and transverse pressure gradients, electric fields, and heat transfer rates at open circuits and short circuit, both with cold and hot insulator walls. The data indicated internal short-circuiting through high-conductivity gas layers on the electrode walls as well as current flow in the insulator wall layer. Boundary layer separations seem to dominate the channel exit region. (auth) (UK)

23848 A CYLINDRICAL COAXIAL MHD GENERATOR. Rao, K. R. (Univ. of Texas, Arlington); Erteza, A. Appl. Sci. Res. (The Hague); 21: 427-41(Jan 1970).

A MHD generator with a novel geometry as a possible dc power source is analyzed. The generator channel consists of two coaxial cylinders with a smooth annular space between them through which pressure-driven ionized gas flows axially. Magnetic poles and electrodes separated by insulators are embedded in both the inner and outer cylinders. A one-dimensional steady-state analysis is presented. It is shown that the internal impedance of the generator is a very sensitive function of the ratio of areas of the charge-collecting electrodes to that of the magnetic poles. The generator efficiency analysis, on the other hand, indicates that there is an optimum area ratio corresponding to the maximum conversion efficiency. A comparison of the performance characteristics of this generator with those of a generator of rectangular cross section is presented. The average gas temperature and velocity, the magnetic flux density at the poles, and the volume displacement rate, etc., are assumed identical for the two cases in comparison. It is inferred that the novel channel analyzed is, in general, superior to the simple rectangular channel in the energy conversion scheme. (auth)

23849 THERMIONIC CONVERTER ASSEMBLIES. Levedahl, William John (to Martin Marietta Corp.). British Patent 1,182,799. 4 Mar 1970. Priority date 7 Nov 1966, United States.

A radioisotope-powered thermionic converter is designed with the collector-radiator structure functioning as a heat pipe for maximum efficiency in waste heat rejection. The heat pipe has a radiator configuration involving an enclosure of spaced heat-rejecting and -receiving surfaces. Several alternate designs are shown. (D.L.C.)

Fluid Physics

Refer also to abstract 24085.

23850 FLOW OF A VISCOUS AND CONDUCTING FLUID AROUND A SPHERICAL SHELL. Levy, Therese (Service de Mecanique Theorique, Paris). Compt. Rend., Ser. A; 269: 1221-4(22 Dec 1969). (In French).

The stationary flow of an incompressible viscous and electrically conducting fluid around a hollow sphere is considered, the velocity of the flow and the magnetic field to infinity being uniform and parallel. (J.F.P.)

23851 DEVELOPMENT OF FLOW TYPES OF CONDUCTING FLUID THROUGH A TRANSVERSE MAGNETIC FIELD. Chou, T. L. (Michigan Technological Univ., Houghton). pp 155-72 of Recent Advances in Engineering Science. Vol. 4. /Eringen, A. C. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From 5th Meeting on Recent Advances in Engineering Science, Huntsville, Ala. See CONF-671091.

The effect of a magnetic field on the flow of conducting fluid is the basis of some scientific and astronomical problems and many investigations have been carried out recently. In this paper, statistical studies of turbulence in both hydrodynamic and magnetic fields are discussed, and important stages of the interlocking action of the two fields are enunciated. By using mercury as the conducting fluid, experimental results are obtained. It is found that the empirical formulae check closely with the statistical values. As the magnetic field increases, there is a maximum limit to this interlocking action beyond which the flow resistance increases. It is also shown that there are three distinct flow types: laminar, turbulent, and suppressed turbulent. The last is different from laminar in that, in addition to the turbulence damped out by interlocking, there is a remaining turbulence separating the given flow from the laminar one. It is also pointed out that (a) the economic way of controlling turbulence by a magnetic field is to apply a field strength slightly above the critical Hartmann number, and (b) the suppressed turbulence is in dynamic balance in the direction of the applied field, and extreme care should be exercised to keep control and to prevent any external disturbances. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 22990, 23830, 23942, and 24103.

23852 (D-1-82-939) DIFFRACTION OF VLF WAVES BY THE MOON. GiaRusso, Don P. (Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.). Dec 1969. 23p.

The diffracted field of a vlf source located in the presence of a lossy dielectric sphere embedded in an isotropic plasma is investigated. The results show an increase in diffracted energy as the source frequency approaches the plasma frequency. A quantitative description of the field near and at the antipode of the source is given. (auth)

23853 (FOA-4-4415) EFFECTS OF NUCLEAR EXPLOSIONS ON THE IONOSPHERE. Witalis, E. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Feb 1970. 23p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

In a summarized and an essentially qualitative form the effects of nuclear explosions at ionospheric or higher altitudes are described. A review of the most important aspects of high altitude explosions such as geophysical, cosmophysical, telecommunications, etc., are given. The structure of the ionosphere and its qualities of interest are discussed followed by an investigation of effects of primary ionizing irradiations from nuclear explosions and some more complicated effects from neutron emission and radioactive fission fragments. Finally the effects on the distribution of radio communication signals from the increased ionizations are discussed. (tr-auth) (Sweden)

23854 LONGITUDINAL STRUCTURE IN THE PLASMAPAUSE: VLF GONIOMETER OBSERVATIONS OF KNEE WHISTLERS. Bullough, K.; Sagredo, J. L. (Univ. of Sheffield, Eng.). Nature (London); 225: 1038-9(14 Mar 1970).

A study of "knee-whistlers" observed on July 26, 1967 by means of a wide-band vlf goniometer receiver at Halley Bay, Antarctica, showed the existence of masked longitudinal variation in electron tube content (electrons/cm^2-tube) on an L-shell just outside the plasmapause. During the period under study the whistlers in ducts near the plasmapause fell into eight groups, two of which occurred just inside the plasmasphere at L ≃ 4.2, the remainder, which were "knee-whistlers", occurring just outside at L ≃ 4.7 to 4.8. Sonagrams of the whistlers are reproduced. For a short period the whistler groups occurred simultaneously, so that it was possible to determine the relative travel times at the nose frequencies rather precisely. Histograms of measurements of the azimuth of whistler exit points are shown; there are significant differences in the azimuthal bearings of the exit points of the knee-whistlers. The generalised invariant latitude for an altitude of 100 km was calculated for each group, and it is clear that all the knee-whistlers occurred in ducts lying very close to the same L latitude. Values were obtained for equatorial electron density and tube content; the density decreased by an order of magnitude across the plasmapause, whilst the tube content dropped by ten to fifty times. An interesting observation was a marked longitudinal variation of 3:1 in the tube content moving westward along the same L shell. The existence of plasmapause structure must be borne in mind in the interpretation of knee-whistlers, and merits the use of a goniometer to distinguish such features from the latitudinal multilevel structure which was observed from satellites during magnetic storms. (UK)

23855 PROPAGATION OF LOW-FREQUENCY MHD WAVES THROUGH THE EARTH'S MAGNETIC TAIL. Prikner, Karel (Geophysical Inst., Prague). Stud. Geophys. Geod.; 14: 67-82 (1970).

An attempt is made at presenting an illustrative model of the propagation of waves, restricted by the tail geometry, considering an analogy with a hydromagnetic plasma waveduct under extreme conditions. It is pointed out that only further facts about the physical properties of the tail will make a more detailed theoretical approach to the problem possible. (TSS)

23856 BASIC SOURCES OF EXCESSIVE ABSORPTION IN NIGHT E LAYER OF IONOSPHERE. Nestorov, G. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 1385-8(1969).

About one half of the cases of excessive absorption are due to the penetration of solar particles (ionizing electrons) that reach a height of 100 to 120 km at medium latitudes. The other half of the cases is due to meteorological and other causes. The fact that the greatest number of cases coincides with the winter months (December and January) testifies to higher temperatures in the base of the thermosphere. A certain number of cases of increased absorption of the latter group may be due to dynamic causes (vertical transport of electrons), but to establish such a connection is at present a rather complex task. The number of sunspots alone cannot serve as yardstick for absorption in the night E-layer. One of the indexes of geomagnetic activity (A_k or K) must also be taken into consideration, and when describing the seasonal changes also a meteorological factor say, temperature variations in the base of the thermosphere. A certain dephasing of the frequency of proton flares by about two years (maximum in 1960) in relation to the years of maximum solar activity is confirmed independently in the present work. When describing the cyclic course of absorption in the night E layer it is therefore necessary to take into consideration the frequency of proton flares, resp. the bursts type IV which correlate with the former. (auth)

23857 TWO-DIMENSIONAL MODEL OF MAGNETOSPHERE. Sigov, Yu. S. Kosm. Issled.; 7: 731-7(Sep-Oct 1969). (In Russian).

A two-dimensional stationary problem on magnetospheric structure and form produced by streaming of rarefied plasma is analyzed for the case in which the dynamic and stationary components are present simultaneously. A conform-conversion method with subsequent numerical integration was used for resolving the problem. Calculations were also made of a magnetic dipole which was orthogonal and parallel to the plasma flux flow. (tr-auth)

23858 MAGNETIC PERTURBATIONS IN MAGNETOSPHERE INDUCED BY SOLAR-WIND TANGENTIAL BREAK. Mikerina, N. V. Kosm. Issled.; 7: 794-5(Sep-Oct 1969). (In Russian).

Variations of the solar-wind parameters induced by a sudden pulse in a magnetic field on the surface of the Earth were recorded by Vela-2 on April 18, 1965. An analysis of the overland magnetic perturbation led to the assumption that during such perturbation in the medium latitudes at the day side of the Earth, the compression effect was either small or nonexistent and the perturbation was induced by ionospheric sources. Explorer-26 recorded the phenomena inside the magnetic field. Data obtained were used for studying the perturbation as a result of the tangential break of solar wind. The theoretical relation between the variations of the dynamic solar wind and the magnitude of geomagnetic field was previously obtained by G. D. Mead (J. Geophys. Res., 69: 1181(1964)) with various approximations (and without taking into account the solar wind magnetic field, the influence of the circular current, etc.). An attempt was made of using Mead's data for calculating variations of the modulus of complete magnetic field vectors $\Delta B_T = \sqrt{\Delta X^2 + \Delta Y^2 + \Delta Z^2}$, induced by the incoming tangential break at the magnetosphere boundary at the distance of 3.7 R_E at the geomagnetic latitude of 8° (the location of the satellite). Data obtained on field deformation when correlated with measurements inside the magnetosphere indicate significant discrepancies and confirm the assumption on the leading role of the ionospheric current in the perturbation of the geomagnetic field on the day side of the Earth. Further assumptions on simultaneous increase of energy along the whole magnetosphere proved inconclusive. (R.V.J.)

23859 CORPUSCULAR RADIATION AS A SOURCE OF LOWER IONOSPHERE IONIZATION IN NIGHTTIME. Tulinov, V. F. Kosm. Issled.; 7: 738-40(Sep-Oct 1969). (In Russian).

Concentration of positive ions in the lower ionosphere at mean latitudes during nighttime was calculated, using the data from direct measurements of corpuscular radiation at specific elevations and new data on ion recombination constants. It is shown that the energy of the corpuscular ionization source was sufficient for producing a relatively high content of ions in the lower ionosphere in the nighttime. (tr-auth)

23860 ION DENSITIES IN THE NIGHT IONOSPHERE. Howard, Russell A. (Univ. of Maryland, College Park); Vanderslice, Joseph T.; Tilford, S. G. Planet. Space Sci.; 18: 145-53 (Feb 1970).

The nighttime concentration profiles of the major ions in the ionosphere between 120 and 450 km have been calculated from the known daytime concentrations. Agreement between the observed and calculated nighttime profiles of the O^+, NO^+, O_2^+ ions is quite good if one allows normal Chapman–Enskog diffusion as well as the known chemical reactions to occur. By preserving electrical neutrality, good agreement is also obtained between the observed and calculated electron concentrations. The concentration profiles were found to be highly sensitive to the values of the reaction rate constants. (auth) (UK)

23861 MEASUREMENTS OF TOTAL ELECTRON CONTENT AT HUANCAYO, PERU. Bandyopadhyay, P. (Instituto Geofisico del Peru, Huancayo). Planet. Space Sci.; 18: 129-35(Feb 1970).

Measurements of total electron content of the ionosphere above Huancayo, Peru, by observation of Faraday fading of satellite signals during January through March 1967 are reported. The data are examined to study principally the diurnal variation of total electron content and of equivalent slab thickness as well as the latitudinal variation of the electron content. The diurnal variation is characterized by the occurrence of a midday biteout. The equivalent slab thickness reaches a peak around midday besides exhibiting a hump in the early morning hours. The latitudinal variation of electron content in the afternoon shows a dip around the magnetic equator. (auth)

23862 SUMMER DAYTIME HEIGHT PROFILES OF $O_2(^1\Delta)$ CONCENTRATION AT FORT CHURCHILL. Wood, H. C.; Evans, W. F. J.; Llewellyn, E. J.; Jones, A. Vallance (Univ. of Saskatchewan, Saskatoon). Can. J. Phys.; 48: 862-7(1 Apr 1970).

The height distribution of $O_2(^1\Delta)$ molecules was measured during the daytime by means of filter photometers flown to 95 km on Black Brant III rockets. The height distributions obtained show main peaks at 55 km (afternoon, solar elevation 18.2°) and at 59 km (morning, solar elevation 9.2°). The concentrations above 80 km show significant enhancements over those predicted from ozone photolysis on the basis of the ozone concentrations predicted by most previous theoretical models. (auth)

23863 RADIOWAVE ABSORPTION AT AN AURORAL LATITUDE. Gregory, J. B.; Manson, A. H.; Rees, D. T. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys.; 48: 809-13(1 Apr 1970).

Radiowave absorption at 2.2 MHz was measured by the Al method (vertical incidence, pulse), during noon periods from November 1967 to October 1968 at Saskatoon (52°N, 106°W,

61.5° invariant latitude). Monthly mean values are not strongly determined by direct solar control. Maxima of absorption are found in February, and in September–October, during which periods there is increased auroral activity. Correlation with magnetic activity on a daily basis is poor except during these months, and is good only when ΣK_p is greater than 6 (6h) during high absorption events. The "winter anomaly" of absorption, as evidenced in a log ρ, log (cos χ) plot, is present in modified form, when compared to mid-latitude seasonal variations. A regression equation shows that the response of absorption to changes in stratospheric temperatures over the Canadian prairies is less than to changes in K_p and is below the significance level of 10%. The coefficients of the temperature and K_p terms in the regression relation for eastern Canada (Ottawa, L = 3.6) are highly significant. (auth)

23864 DEVELOPMENT OF SUDDEN IONOSPHERIC DISTURBANCES (SID) ASSOCIATED WITH SOLAR COSMIC-RAY FLARES. Sakurai, Kunitomo (Kyoto Univ.). J. Geomagnet. Geoelec.; 20: 271-80(1968).

Solar cosmic-ray flares are always followed by intense sudden ionospheric disturbances (SID). By examining the developing process of SID's, some problems such as the characteristics of cosmic-ray flares and associated x-ray emissions and the generation of high-energy particles are investigated. The nature of cosmic-ray flares is closely related to some observed characteristics of solar cosmic rays and the developing process of SID's. The emission process of solar-flare x rays and its relation to the acceleration of energetic particles are considered. (auth)

23865 ASYMPTOTIC BEHAVIOR IN THE COLD-PLASMA MODEL OF THE MAGNETOPAUSE. Davies, C. M. (London Univ.); Sestero, A. Lett. Nuovo Cim.; 3: 263-7(19 Feb 1970).

In previous papers the authors obtained numerical solutions describing the structure of the boundary layer between a plasma stream and a vacuum magnetic field. Cold-plasma equations were used, taking into account the charge separation in the boundary layer, and solutions were obtained for various angles of incidence of the plasma stream on the boundary, and for various degrees of neutralization. In this note a unified discussion of the various solutions is provided by examining their asymptotic behavior in the region upstream, far from the main current layer. (TSS)

23866 THEORY OF GEOMAGNETIC MICROPULSATIONS. II. Sen, Amiya K. (Columbia Univ., New York). J. Geomagnet. Geoelec.; 20: 245-61(1968).

The amplitude spectra of micropulsation signals at the surface of the Earth are essentially determined by the resonances of the transmission path. On the other hand, the power spectral density depends both on the squared amplitude of transmission and the occurrence or persistence probability. This latter probability is a function of the sensitivity of the overall transmission on the variation of the path length in the outer magnetosphere. A crude analysis based on this sensitivity yields spectral peaks at time periods of approximately 2.5, 6, 11, and 20 seconds with a slope of 6 db/octave at long time periods only. (auth)

23867 LARGE-AMPLITUDE Pc 1 EVENTS AT COLLEGE. Heacock, R. R. (Univ. of Alaska, College). J. Geomagnet. Geoelec.; 20: 263-9(1968).

The Pc1 events with amplitudes over ~½γ recorded at College, Alaska, over a 6½-year interval, were studied. Their general characteristics are described. Sonagram displays and polarizations are similar to those for smaller events, but there is typically more ionospheric cosmic noise absorption accompanying the large events, and the large events are usually observed at only one station. It is proposed that large amplitudes observed on the ground are at least partially due to the presence of unusually well defined waveguides of enhanced ionization along magnetospheric field lines. (auth)

23868 THEORY OF GEOMAGNETIC MICROPULSATIONS. I. Sen, Amiya K. (Columbia Univ., New York). J. Geomagnet. Geoelec.; 20: 225-43(1968).

A theory of one of several possible mechanisms responsible for micropulsations is presented. It is shown that hydromagnetic waves generated by an instability of the interface between the solar wind and magnetosphere are transmitted through the magnetosphere and received on the surface of the Earth as micropulsations. The bandwidth of the micropulsations, essentially determined by the source mechanism, is found to be a few tenths of a second to hundreds of seconds. The important role of the path in the magnetosphere, including that in the outer exosphere in determining the transmission characteristics of micropulsations, is analyzed. The crucial role of the slightest variation of the path length in the outer magnetosphere (due to variations in the solar wind) in masking out the resonances of the lower exosphere and upper ionosphere is discussed. The resonances in transmission due to the path in the outer magnetosphere are seen to be more likely than those of the lower exosphere and upper ionosphere. (auth)

23869 INFLUENCE OF COULOMB COLLISIONS ON ELECTROSTATIC WAVES IN THE IONOSPHERE. McBride, J. B.; Pytte, A. (Dartmouth Coll., Hanover, N. H.). Planet. Space Sci.; 18: 155-8(Feb 1970).

The collisional damping rate of electrostatic LHR waves is calculated. At an altitude of 1000 km, the damping rate is typically a few sec^{-1}. In the absence of an instability the LHR waves should therefore damp out in a time of the order of a second. Horita and Watanabe (1969) attribute the LHR noise bands to a Landau instability excited by high energy (~10 keV) electron streams. The instability growth rate depends on the thermal spread in the stream, but can exceed the collisional damping rate if this thermal spread is not too large. One effect of the collisional damping is to shift the lower cutoff of the noise bands up above the LHR frequency, the extent of the shift being dependent on the thermal spread in the electron stream. (auth) (UK)

23870 ION COMPOSITION AND ION CHEMISTRY IN AN AURORA. Donahue, T. M.; Zipf, E. C. Jr.; Parkinson, T. D. (Univ. of Pittsburgh). Planet. Space Sci.; 18: 171-86(Feb 1970).

Ion composition measurements are reported as obtained with a rocket borne mass spectrometer flown during an aurora. At the level of highest ion production near 115 km the NO^+ density was a factor of 3 larger and the O_2^+ density a factor of 10 smaller than expected from normal composition, temperature, and ion chemistry models. The O^+ density was a factor of 50 larger than expected. The results appear to demand effective ion temperatures greater than 1000°K and electron temperatures even larger. They also require efficient channels for conversion of O_2^+ to NO^+. Reactions of O_2^+ with anomalously abundant NO or N or with vibrationally excited N_2 are regarded as possible modes for transforming O_2^+ into NO^+. Densities of He^+ in excess of 50 cm^{-3} were observed and not understood. The O_2^+ densities measured are too low to permit dissociative recombination to contribute significantly to O I green line excitation except at high altitude. (auth) (UK)

23871 ROCKET INVESTIGATION OF THE AURORAL GREEN LINE. Parkinson, T. D.; Zipf, E. C. Jr.; Donahue, T. M. (Univ. of Pittsburgh). Planet. Space Sci.; 18: 187-98(Feb 1970).

Results obtained from rocket-borne photometers, electron energy analyzers and ion mass spectrometers show that direct excitation of atomic oxygen by auroral electrons can excite only a small fraction of the auroral green line observed. From measured ion distributions, dissociative recombination of O_2^+ is shown to contribute only weakly to the excitation of $O(^1S)$ except at high altitudes. It is proposed here that dissociative excitation of O_2 can account for the major portion of the production of $O(^1S)$ if the cross section for the process is of order 10^{-16} cm^2. Dissociative recombination supplements this mechanism at high altitude and produces about 10% of the total emission. (auth) (UK)

23872 THREE-FLUID MODEL OF SOLAR WINDS. Yeh, Tyan (Univ. of California, San Diego, La Jolla). Planet. Space Sci.; 18: 199-215(Feb 1970).

A three-fluid model of solar winds is studied, in which the three constituents, electrons, protons and alpha particles, are coupled by an electric field. Each constituent expands isothermally under the action of a pressure gradient and solar gravitation. It is found that the three-fluid hydrodynamic equations possess a critical solution, in which all three constituents expand supersonically to infinity. In this hydrodynamic equilibrium the abundance of alpha particles compared to protons decreases as the solar plasma expands. (auth) (UK)

23873 A SUMMERTIME MIDNIGHT ENHANCEMENT OF 6300A AIRGLOW. Nichol, D. G. (Tasmania Univ., Hobart, Australia). Aust. J. Phys.; 23: 109-10(Feb 1970).

Intensity measurements of the 6300 Å line of (O I) from the $^3P \rightarrow {}^1D$ transition were obtained in Hobart (54°S. geomagnetic) during the summers of 1968 and 1969, using a sensitive continuum compensating photometer. An intensity enhancement of the order of 10R occurred for (Kp < 2) lasting for 2 hr, commencing near local midnight. For (Kp > 3) the enhancement would be several times larger. The $O(^1D)$ state of oxygen is believed to originate from excitation by electron input or dissociative recombination of O_2^+. (Australia)

23874 IONOSPHERIC ELECTRON CONTENT AT TEMPERATE LATITUDES DURING THE INCREASING PHASE OF THE

SOLAR CYCLE. Rao, N. Narayana; Yeh, K. C.; Youakim, M. Y. (Univ. of Illinois, Urbana). Aust. J. Phys.; 23: 37-43(Feb 1970).

Ionospheric electron content results obtained from the radio beacon satellite BE-B during the increasing phase of the solar cycle 1964-8 are presented. The diurnal, seasonal, solar cycle, latitudinal, and day to day variations of electron content are discussed. (Australia)

23875 VAN ALLEN BELT PLASMA PHYSICS. Kennel, C. F.; Petschek, H. E. (Avco Everett Research Lab., Everett, Mass.). pp 95-150 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The following topics are discussed: (1) Van Allen belt observations, (2) linear pitch-angle anisotropy instabilities in the magnetosphere, (3) general properties of weak electromagnetic wave turbulence, (4) upper limit to stably trapped particle fluxes, and (5) parasitic diffusion. (M.O.W.)

23876 OBSERVATION OF SOLAR-WIND α-PARTICLES IN THE MAGNETOSHEATH. Formisano, V. (CNR, Rome Univ., Rome); Egidi, A.; Moreno, G. Lett. Nuovo Cim.; 3: 209-12 (12 Feb 1970).

Data obtained by HEOS-1 on well-defined fluxes of α particles within the magnetosheath are discussed. A particularly clear-cut case of α-particle thermalization is reported which occurred during a multiple transition along the out-bound leg of orbit 13, Feb. 4, 1969. (W.D.M.)

23877 STUDY OF EQUATORIAL GEOMAGNETIC MICRO-PULSATIONS. Channon, M. J. (Makerere University Coll.; Kampala, Uganda); Orr, D. Planet. Space Sci.; 18: 229-37 (Feb 1970).

Oscillations of the geomagnetic field with periods between 10 sec and a few minutes have been studied using the Earth current technique at Makerere University College, Kampala, Uganda, for the year 1966. For Pc4 pulsations, the diurnal variation of average period was "u" shaped having longer periods at night than during the day. There was no simple relationship between period and K_p index and, unlike Pc3, the percentage occurrence does not increase linearly with K_p index. Pc4 occurred most frequently just predawn, this is in contrast to the noon peak observed at middle latitudes and under the equatorial electrojet. Pc3 occurrence frequency peaks at midday, the period was found to depend on K_p, thus T (in sec) = 36 -2.2 K_p. During times of moderate geomagnetic activity ($K_p \sim 2-4$) there was a distinctive variation of Pc3 period having the maximum period soon after local midnight and the minimum period around mid-day. Pi2 events were also K_p dependent, the number of events increasing approximately linearly with K_p (up to $K_p = 4$) and the period T (in sec) = 92 - 11.4 K_p. (auth) (UK)

23878 OBSERVATIONS OF MAGNETOPAUSE GEOMETRY AND WAVES AT THE LUNAR DISTANCE. Mihalov, J. D. (Ames Research Center, Moffett Field, Calif.); Colburn, D. S.; Sonett, C. P. Planet. Space Sci.; 18: 239-58(Feb 1970).

Magnetic observations at the lunar distance of the magnetopause, or boundary between the geomagnetic tail and the magnetosheath, are surveyed. The boundary surfaces are shown to have normal vectors from which an average tail aberration induced by the Earth's heliocentric motion of $9 \pm 5°$ and a flaring half-angle of ~9° is found. The boundary is assumed to be a tangential discontinuity. The average ecliptic diameter of the tail at lunar distance is 50 Earth radii. Using 21 normal vectors, a statistical variation transverse to the tail axis three times that along the axis is shown. This may correspond to magnetic perturbations induced by the Kelvin–Helmholtz instability; the variations of the unit normals are consistent with circumferential oscillations having wavelengths smaller by $\frac{1}{3}$ to $\frac{1}{10}$ than those of waves moving in the downstream direction. The circumferential oscillations appear to give evidence of fluting of the tail surface. Several distinct types of boundary signature are identified. Boundary speeds which usually exceed typical spacecraft velocities of ~1 km sec^{-1} are deduced from simple models of boundary motion. Implied boundary thicknesses are usually ~1000 km, but perhaps are as low as ~30 km in some instances. Use of K_P as an indicator of solar wind conditions does not reveal correlation with the number of multiple crossings or the changes in magnetic field magnitude across the boundary. (auth)

23879 ELECTRIC FIELD MAPPING IN THE IONOSPHERE AT THE EQUATORIAL PLANE. Mozer, F. S. (Univ. of California, Berkeley). Planet. Space Sci.; 18: 259-63(Feb 1970).

The relationship between the components of electric field perpendicular to the magnetic field line in the ionosphere and at the equator is computed for dipole and distorted magnetic field models under the assumption that magnetic field lines are electric equipotentials. Since the electric field direction is not preserved in this mapping process one can resolve the apparent conflict between electric fields measured in the ionosphere and convection patterns in the equatorial plane. The possible error in the assumption that magnetic field lines are electric equipotentials is discussed. (auth) (UK)

23880 ATOMIC OXYGEN INFRARED EMISSION IN THE EARTH'S UPPER ATMOSPHERE. Kockarts, G.; Peetermans, W. (Institut d'Aeronomie Spatiale de Belgique, Brussels). Planet. Space Sci.; 18: 271-85(Feb 1970).

The atomic oxygen emission at 63μ is analyzed between 50 and 250 km for several atmospheric models. The frequency-integrated intensities and the volume emission rates are computed and discussed in connection with experimental and theoretical investigations of the atomic oxygen distribution. It is shown that radiative transfer should be used below 150 km. If an infrared emission occurs near the tropopause, the radiative transfer solution leads to an infrared heating near the mesopause. A reduction factor is introduced for comparison with an optically thin atmosphere. (auth) (UK)

23881 OCCURRENCE OF HYDROMAGNETIC EMISSIONS AT TWO SOUTHERN HEMISPHERE SITES. Manchester, R. N.; Fraser, B. J. (Univ. of Newcastle, Australia). Planet. Space Sci.; 18: 291-7(Feb 1970).

Analysis of occurrence of hydromagnetic emissions recorded during 1967 at two Australian stations, Newcastle and Hobart, has shown that about two thirds of the activity recorded at a given station, including most large-amplitude events, is recorded simultaneously at the other station. Most events having a mid-frequency above 2.0 Hz occurred simultaneously at the two stations. Propagation of these events in the ionospheric hydromagnetic duct is shown to have a significant influence on the middle-latitude occurrence statistics. (auth) (UK)

23882 PROPAGATION OF HYDROMAGNETIC EMISSIONS IN THE IONOSPHERIC DUCT. Manchester, R. N. (Univ. of Newcastle, Australia). Planet. Space Sci.; 18: 299-307(Feb 1970).

Measured values of group velocity and attenuation of hydromagnetic emissions are compared with values computed assuming propagation in the duct centered on the F2 region of the ionosphere. In general, good agreement is obtained between the observed and calculated results. (auth) (UK)

23883 AN IDEALIZED PROBLEM ILLUSTRATING THE EFFECT OF THE IONOSPHERE ON TOROIDAL WAVES. Hruska, A. (Univ. of Alberta, Edmonton). Planet. Space Sci.; 18: 315-16(Feb 1970).

A previous paper (Hruška, ibid, 16: 1305) gave a general discussion of the effect of the boundary conditions on the possible order of magnitude of the value of the length-scale, $L_\perp$. The present paper gives an elementary illustration of the effect for one simple model. (auth) (UK)

23884 THEORETICAL MODEL OF A MICROWAVE PROBE FOR A RE-ENTRY PLASMA. Samaddar, S. N. (Raytheon Co. Sudbury, Mass.). Int. J. Electron.; 28: 341-8(Apr 1970).

A theoretical model of a microwave probe for a re-entry plasma, by using a circular waveguide fed in the lowest-order circular TE_{01} mode, is developed. The reflection coefficient or the aperture admittance to the probe is calculated by a variational method. Radiated field is determined by employing a saddle point method of integration. In addition, expressions for surface wave contribution to the field inside the plasma and the reflection coefficient are also presented. The plasma is assumed to be inhomogeneous in the direction parallel to the axis of the waveguide. (auth) (UK)

23885 ELECTRON BEAM CALIBRATION OF ELECTRON DENSITY PROBES. Naraghi, M. (Aria-Mehr Univ. of Tech., Teheran). Int. J. Electron.; 28: 301-9(Apr 1970).

A new technique is developed to calibrate the electron density probes, designed for vehicles returned to the Earth's atmosphere, in the very critical range of 10^9 to 10^{11} electrons/cm^3. The probe consists of an electromagnetic cavity whose resonant frequency is altered by introducing a plasma column in the region of maximum microwave electric field. The calibration is made for a distorted cylindrical cavity as required by the aerodynamic conditions set on the probe, with a TM 010 mode, by using a high-perveance electron beam gun whose electron density is determined from the characteristics of the beam. (auth) (UK)

23886 ATTI DEL CONVEGNO ANNUALE XVII, ROMA, 7–9 MARZO 1968. ASSOCIAZIONE GEOFISICA ITALIANA. PARTE 1. (Proceedings of the 17th Meeting, Rome, March 7–9,

1968. Italian Geophysics Society. Part 1). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 1-296(Mar 1968). (CONF-680332-(Pt.1)).

Twenty-two papers given at the meeting are presented in this part. Individual abstracts were prepared for four of the papers. The other papers were not in scope of NSA. (J.S.R.)

For abstracts of individual papers see: 22783, 22793, 22794, and 23840.

23887 ATTI DEL CONVEGNO ANNUALE XVII, ROMA, 7-9 MARZO 1968. ASSOCIAZIONE GEOFISICA ITALIANA. PARTE 2. (Proceedings of the 17th Meeting, Rome, March 7-9, 1968. Italian Geophysics Society. Part 2). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 305-707(Mar 1968). (CONF-680332-(Pt.2)).

Twenty-eight papers given at the meeting are presented in this part. Individual abstracts were prepared for two of the papers. The other papers were not in scope of NSA. (J.S.R.)

For abstracts of individual papers see: 22795 and 23888.

23888 CALCULATIONS OF THE MAGNETIC ZENITH. Gregori, G. P. (Consiglio Nazionale delle Ricerche, Rome). Ass. Geofis. Ital., Atti Conv. Annu.; 17: 319-23(Mar 1968). (In Italian).

From 17th Annual Conference of the Italian Geophysical Society, Rome, Italy. See CONF-680332-(Pt.2).

A few methods to compute the geomagnetic zenith at a given point, on the basis of a given model of the geomagnetic field, are discussed. (tr-auth)

Low-Temperature Physics

Refer also to abstract 23445.

23889 (AD-698270) THE FERMI SURFACE AND DELTA (K) OF SUPERCONDUCTING Nb. MacVicar, Margaret L. A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science). Nov 1969. Contract Nonr-3963(16). 14p. (TR-10). CFSTI.

Examination of available tunneling data from junctions oriented on single-crystal niobium, shows that the observed superconducting energy gap values are grouped nonrandomly in K-space. These groupings suggest a relationship between delta (K) and Fermi surface topology, and may suggest a significant role for phonon anisotropy. (auth) (USGRDR)

23890 (AD-698271) AN INVESTIGATION OF LOW-ENERGY STRUCTURE IN NIOBIUM SINGLE CRYSTALS BY TUNNELING. Hafstrom, John W.; Rose, Robert M. (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy and Materials Science). Nov 1969. Contract Nonr-3963(16). 72p. (TR-11). CFSTI.

An investigation of low-energy superconductive tunneling into very pure single-crystal niobium was performed. Lead and indium films, evaporated onto oxide barriers, were used as the probe. Evidence was found for a second energy gap in niobium at delta/10. The gap is temperature-independent and agrees with various theoretical predictions. Additional new voltage structure is found in junctions formed with lead, indicative of tunneling processes occurring within the barrier. Various processes are proposed to explain the structure. (auth) (USGRDR)

23891 (BNL-14524) PHONON SPECTRA, IMPURITIES AND SUPERCONDUCTING TRANSITION TEMPERATURES. Choyce, Brenda (Brookhaven National Lab., Upton, N. Y.). 18 Mar 1970. 37p. Dep. CFSTI.

The superconducting transition temperature is affected by the introduction of impurities into the material of a particular case of strong-coupling superconductors and is dependent only on the lattice dynamics of the metal through a parameter $\langle\omega\rangle/\langle\omega^{-1}\rangle$. Assuming that McMillan's observation is generally correct, the effect of isolated impurities on the transition temperature can be calculated from their effect on the parameter. The reduced parameter $2R\langle\omega\rangle/\omega_D^2\langle\omega^{-1}\rangle$ is calculated for different models of the phonon density of states and for the phonon density of states of niobium determined from inelastic neutron scattering. This was done by using Elliott's exact solution of the lattice dynamics of a substitutional impurity with only a mass discrepancy (no change in the binding forces is considered). The results of these calculations indicate that the reduced parameter is dependent linearly on the logarithm of R, the ratio of the mass impurity to the atomic lattice mass, for most reasonable models. Further, the coefficient of the ln(R) term is independent of the model, a rather surprising result. (auth)

23892 (NBS-TN-482) SUPERCONDUCTIVE MATERIALS AND SOME OF THEIR PROPERTIES. Roberts, B. W. (General Electric Co., Schenectady, N. Y. Research and Development Center). May 1969. 129p. GPO $1.25.

This is a noncritical compilation of data on superconductive materials that has been extracted from a portion of the literature published up to early 1968. The properties concerned are composition, critical temperature, critical magnetic field, crystallographic data, and lowest temperature tested for superconductivity. The compilation also includes a bibliography and a special tabulation of high-magnetic-field superconductors. (auth)

23893 CONDITIONS FOR THE EXISTENCE OF A MIXED SUPERCONDUCTING AND EXCITONIC PHASE IN SEMI-METALS. Wong, K. W. (Univ. of Southern California, Los Angeles); Lo, S. C. Phys. Lett.; 31A: 260-1(9 Mar 1970).

The possibility of forming either the excitonic state or a mixed superconducting and excitonic state is discussed using a simplified Hamiltonian. Two successive canonical transformations of the Hamiltonian are made. (M.H.R.)

23894 THIN SUPERCONDUCTING FILMS IN A UHF FIELD. II. NONLINEAR PROPERTIES OF THIN SUPERCONDUCTING FILMS IN A UHF FIELD. Eru, I. I.; Kashchei, V. A.; Peskovatskii, S. A. (Inst. of Radio Physics and Electronics, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 778-85(Mar 1970). (In Russian).

The nonlinear properties of thin ($d < \lambda_L(0)$, $d < \xi_0$) lead, tin and indium superconducting films in a uhf field (10^{10} Hz) are investigated experimentally at temperatures between 1.5 and 4.2°K. The results, which can be explained by excitation of Cooper pairs via the energy gap by a uhf current, agree well with the pair excitation mechanism considered in the first part of the paper, despite the fact that the results were obtained with films possessing a nonuniform current distribution along the film length. The results also indicate a new possibility of observing the behavior of the principal superconductor parameters and measuring their relaxation rate. (auth)

23895 EMISSION AND PROPAGATION OF SOUND IN SUPERFLUID ^{3}He-^{4}He SOLUTIONS. Dikina, L. S.; Rudavskii, E. Ya.; Serbin, I. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 843-7(Mar 1970). (In Russian).

It is found that a surface with a periodically varying temperature in a superfluid ^{3}He-^{4}He solution emits, along with second sound, also first sound, the intensity of the latter being much greater than the respective values for ^{4}He. The temperature dependence of the pressure amplitude in the first sound wave excited in this way is investigated; the dependence is in satisfactory agreement with the theoretical predictions. (auth)

23896 THIN SUPERCONDUCTING FILM IN AN UHF FIELD. Peskovatskii, S. A. (Inst. of Radio Physics and Electronics, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 897-902(Mar 1970). (In Russian).

Dynamic destruction of superconductivity of a thin film by a uhf current is considered within the framework of the phenomenological theory. Excitation of Cooper pairs through an energy gap by a uhf current of frequency $\omega \ll h^{-1}\Delta$ is discussed. The possibilities of studying the gap and the relaxation rate in the condensed state that arise in this case are mentioned. (auth)

23897 SUPERCONDUCTIVITY OF ALLOYED SEMIMETALS. Kopaev, Yu. V. Zh. Eksp. Teor. Fiz.; 58: 1012-19(Mar 1970). (In Russian).

Electron-electron and electron-hole pairing are taken into account simultaneously in the model of an impurity semimetal with an isotropic electron spectrum in which electron scattering by the impurity is neglected. The restriction on the relation between the intraband and interband interactions, which makes such pairing possible, is derived for the case when the dielectric gap due to electron-hole pairing is much greater than the superconducting gap. In the expression for the superconducting gap a large factor for the effective coupling constant is obtained due to increase of the state density at the boundary of the allowed band in the exciton insulator model. In the limit of weak alloying, when the degeneracy energy of "excess" electrons is less than the superconducting gap, the latter can be expressed in terms of an effective coupling constant by means of a power function instead of an exponential function. Thus with respect to electron-electron pairing such a system behaves as a one dimensional system. (auth)

23898 THE GINZBURG-LANDAU EQUATION FOR NON-ZERO ANGULAR MOMENTUM PAIRING. Dribinskii, B. L.; Zelevinskii, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 58: 1057-61(Mar 1970). (In Russian).

An analog of the Ginzburg-Landau equation is derived for a superconductor in which Cooper pairing takes place in states with nonzero pair angular momentum l. The equation is similar

to the radial Schroedinger equation for an l-th partial wave with cubic nonlinearity. Its solution is a "spherical vortex" which is a completely isotropic but spatially nonuniform state in which Cooper pairs as a whole revolve about the vortex center in which the order parameter vanished. It is shown that the vortex state has a free energy minimum as compared with previously proposed solutions. (auth)

23899 DEPOSITION OF THE INTERMETALLIC COMPOUND Nb_3Sn FROM THE GAS PHASE. Kim, Kyong-min (Siemens AG, Erlangen, Ger.). Z. Naturforsch.; 25a: 64-9 (Jan 1970). (In German).

Thermochemical calculations and experimental investigations were made for the vapor deposition of the superconducting intermetallic compound Nb_3Sn through the reduction of the component halides with hydrogen. The standard-free enthalpy ΔK_p the equilibrium constant K_p and the yield α were calculated. The influence of the gas composition and of the temperature on the stoichiometry and yield of the deposited Nb_3Sn were investigated. (auth)

23900 THICKNESS OPTIMISATION FOR DYNAMICALLY STABLE SUPERCONDUCTING TAPES. Brown, G. V. (Lewis Research Center, Cleveland). pp 127-33 of High Magnetic Fields and Their Applications. London; Inst. of Physics and Physical Society (1969).

From International Conference on High Magnetic Fields and Their Applications, Nottingham, England. See CONF-690939.

It is stated that high purity Al offers the possibility of obtaining dynamically stabilized superconducting coils with high superconductor packing fractions and consequent high total current density. The optimum thicknesses of superconducting and normal stabilizing metal (l) were calculated for any value of substrate thickness (d). It was found that the total current density for the optimum thicknesses increases as d decreases. If the composite must be a self-supporting turn in a coil, then for $d/l < \sqrt{2/\xi^2}$ the strength condition limits the current density to values below those permitted by stability considerations alone. The total current density would increase if the superconductor critical current could be increased, but cannot be larger than $Y\epsilon/Br$ for self-supporting turns, where Y is the substrate Young's modulus, ϵ the allowable fractional strain, and Br are coil parameters. The effect on the critical temperature T of "wasted" space such as insulation, cooling channels, etc. is considered for the stability-limited region and for the extreme force limited region. (UK)

23901 A 100 KILO-OERSTED SUPERCONDUCTING COIL MAGNET. Metselaar, J. W.; Jordaan, H. A.; Schutter, J. W.; de Klerk, D. (Kamerlingh Onnes Lab., Leiden). pp 134-8 of High Magnetic Fields and Their Applications. London; Inst. of Physics and Physical Society (1969).

From International Conference on High Magnetic Fields and Their Applications, Nottingham, England. See CONF-690939.

The magnet described was designed to give 100 kOe at 90 A, and is energised by a 100-A 10-V power supply. Details are given of the coil, including its behaviour during energising, and also of the cryostat employed. The wire employed was NbTi for the outer section and Nb_3Sn for the middle and inner sections. (UK)

23902 TESTS OF SUPERCONDUCTING MAGNETIC SYSTEM WITH FIELD H ~20 kOe ON BOARD A SATELLITE. Anashkin, O. P.; Kurnosova, L. V.; Konyakhina, S. S.; Lagar'kov, A. A.; Razorenov, L. A.; Sidyakina, T. M.; Fradkin, M. I. Kosm. Issled.; 7: 786-93(Sep-Oct 1969). (In Russian).

Tests of the superconducting magnetic system in a magnetic analyzer for positrons and electrons produced by primary cosmic radiation are described. The superconducting magnetic system with the field strength of nearly 20 kOe in a special cryostat was installed on board an earth satellite. During the flight the temperature and pressure inside the helium container and the intensity of the magnetic field in the superconducting system were measured. During the initial period of the flight (~6.5 hr) the helium in the cryostat was in a two-phase state. Following the appearance of artificial gravity related to the satellite rotation, the temperature of helium increased rapidly and the system shifted into a single-phase state (supercritical pressure p = 2.4 atm). The magnetic field in the superconducting system remained constant during 13 to 18 hr of the flight. (tr-auth)

23903 POTENTIAL OF SUPERCONDUCTIVE JOSEPHSON TUNNELING TECHNOLOGY FOR ULTRAHIGH PERFORMANCE MEMORIES AND PROCESSORS. Anacker, Wilhelm (IBM Corp., Yorktown Heights, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-5: 968-75(Dec 1969).

The potential of a new technology, based on the superconducting Josephson tunneling effect, has been assessed for use in high-speed computer systems. Josephson tunneling circuits for memory and logic functions can be switched at subnanosecond delay, do not require standby power, and dissipate extremely low energy, typically less than 10^{-13} joule during fast switching operation. High-speed circuits with high packing densities, not limited by power dissipation problems, can therefore be expected. Low thermal noise at cryogenic temperatures ensures reliable operation despite the low energy switching signal. Practically lossless signal transmission via superconducting lines can be exploited for high-speed operation even when sizeable memory and logic modules are assembled. Two random access memory modules have been designed on the basis of single device experiments. Operational characteristics leading to the conclusion that 30 Mbit capacity, less than 1 watt refrigeration requirement (at 3.6°K) and cycle times of 40 ns (in one case) and 15 ns (in the second case), can be achieved are presented. (auth)

23904 NEW NIOBIUM–TIN SUPERCONDUCTOR. Tin Uses; No. 82, 14(1969).

Super-Magloy is a new British alloy for use in the fabrication of superconducting magnets. A current density = 10^6 A/cm^2 is claimed to be possible without Joule heating and there is no power loss except in the external circuits. (Metals Abstr.)

23905 HIGHER-ORDER RESPONSE OF A SUPERCONDUCTOR. Weller, W. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Status Solidi; 35: 567-72(1 Oct 1969).

The response of a superconductor to external fields is considered in arbitrary order. The response is calculated for an imaginary time interval and then analytically continued to real times. In this way it is possible to make use of the theorem proved by Kadanoff and Baym on the identity of the correlation functions connected with the physical and the unphysical problem. The result justifies the method of Gorkov and Eliashberg in which the analytic continuation was performed in the frequency representation. (auth)

23906 MAGNETIC PROXIMITY EFFECT. Hauser, J. J. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev.; 187: 580-3(10 Nov 1969).

The penetration depth of the spin polarization of a magnetic metal (Fe, Ni, or Cr) into a nonmagnetic metal or alloy with a high exchange-enhanced spin susceptibility (Pd and $Ni_{0.58}Rh_{0.42}$) was studied by use of the superconducting proximity effect. Pb/Pd/(Fe or Cr) and Pb/$Ni_{0.58}Rh_{0.42}$/Ni sandwiches as well as Pb/Mo/Cr were prepared by the getter-evaporating and getter-sputtering techniques at 77°K and their transition temperatures were measured without warming up. Since the magnetic penetration depth is very small, the Mo sandwiches were used to rule out the possibility of pinholes through the nonmagnetic metal. Also, the Mo sandwiches permit the evaluation of the superconducting proximity effect in the Pd sandwiches, since molybdenum has a low spin susceptibility, but at the same time the penetration of superconducting pairs is approximately the same in Mo and Pd. The ranges of polarization of Fe and Cr into Pd were found to be approximately 20 ± 10 Å, and the range is possibly less for Ni into $Ni_{0.58}Rh_{0.42}$. Finally, Ni_3Ga/Pb sandwiches (Ni_3Ga was chosen because of its very high spin susceptibility) had transition temperatures consistent with Ni_3Ga being a normal nonmagnetic compound, from which it is concluded that if spin fluctuations are present in Ni_3Ga, they do not lead to appreciable spin depairing. (auth)

23907 SUPERCONDUCTIVITY IN $TlBiTe_2$: A LOW CARRIER DENSITY (III-V)VI_2 COMPOUND. Hein, R. A.; Swiggard, E. M. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 24: 53-5(12 Jan 1970).

Superconductivity was found to occur in samples of $TlBiTe_2$ with nominal carrier densities of approximately 6×10^{20} holes per cm^3. The superconducting transition temperature is 0.14°K and the upper critical magnetic field at the absolute zero of temperature is 10 Oe. Replacing Bi with Sb produces the compound $TlSbTe_2$, which remains normal down to 0.015°K. (auth)

23908 MIXED SURFACE STATE OF A SUPERCONDUCTOR OF THE FIRST KIND. Landau, I. L.; Sharvin, Yu. V. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.), 10: 121-4(Aug. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu, 10: 192-6(Aug. 20, 1969).

The state of a hollow single-crystal cylinder cast from indium with R (300°K)/R (°K) = 1.6×10^4, with diameters d_1 = 5.65 and d_2 = 3.15 mm, and with length 32 mm was investigated. To obtain the current–voltage characteristics of the sample, potential leads spaced 10 mm apart were connected to the central part of the cylinder. The V–I characteristics at 1.39 and 3.6°K are shown. To obtain information on the state of the internal surface of the cylinder, thin niobium wires were welded to it. The observations indicate that the mixed surface state of a type-I superconductor

is stable and is produced on the internal surface of a current-carrying hollow cylindrical sample. (M.H.R.)

23909 MAGNETIC STUDIES OF THE ALLOY SYSTEM SnTe–MnTe. Mathur, M. P.; Deis, D. W.; Jones, C. K.; Patterson, A.; Carr, W. J. Jr.; Miller, R. C. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys.; 41: 1005-7(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Magnetic ordering and superconductivity were investigated in the system $Sn_{0.97-x}Mn_xTe$ for $0.00001 \leq x \leq 0.16$ over the temperature range $0.02 \leq T \leq 300°K$. Reciprocal Hall coefficient, 1/Re, for all these samples was $\sim 10^{21}$ cm^{-3}. Samples with $x > 0.005$ showed ferromagnetic ordering with the Curie temperatures varying linearly with x. For $0.0001 < x < 0.005$, neither magnetic ordering nor superconductivity were observed above 0.02°K. In samples with $x < 0.0001$, superconductivity was observed with the transition temperatures being depressed below that for $Sn_{0.97}Te$ ($T_c \simeq 0.20°K$). Measurements were also made on samples with constant manganese concentration and varying carrier density. Heat capacity measurements between 2 and 30°K showed anomalies attributable to the magnetic coupling of the Mn ions. (auth)

23910 THEORY OF BINARY BOSON SOLUTIONS. Massey, Walter E. (Univ. of Illinois, Urbana); Woo, Chia-wei; Tan, Hing-tat. Phys. Rev., A; 1: 519-28(Feb 1970).

The properties of a dilute solution of mass-3 bosons in liquid ^{4}He at low temperatures are computed via a variational procedure. A set of coupled integro-differential equations is solved, yielding expressions for the ground-state energy per particle, the binding energy of ^{3}He in ^{4}He, the (3,3), (4,3), and (4,4) distribution functions, and the long-wavelength limit of the effective interaction between ^{3}He quasi particles in ^{4}He. Numerical results are obtained and compared with experiment. (auth)

23911 SYSTEM OF BOSONS WITH ATTRACTIVE INTERACTIONS. II. LOW-TEMPERATURE PROPERTIES. Singh, K. K.; Kumar, Satish (Univ. of Delhi). Phys. Rev., A; 1: 497-513(Feb 1970).

The work of an earlier paper on the ground-state properties of a system of bosons interacting via a strong short-ranged repulsive potential and a weak long-ranged attractive potential is extended to nonzero temperatures. The technique of temperature-dependent Green's functions is employed. It is shown that, with the same restrictions on the two-body potential as imposed in the case of the ground state, it is possible to calculate in a consistent fashion the leading low-temperature contributions to the various thermodynamic functions. The results provide support for Landau's point of view for treating the system at low temperatures as a collection of noninteracting quasi particles. The isotherms of the system at the low temperatures considered indicate a first-order transition between a phase with a condensate and one without a condensate, and also the possibility, at higher temperatures, of three phases. (auth)

23912 CRITICAL CURRENT DENSITY AND CRITICAL TEMPERATURE GRADIENT IN THIN FILMS OF TYPE-I SUPERCONDUCTORS. Huebener, R. P.; Rowe, V. A. (Argonne National Lab., Ill.). J. Vac. Sci. Technol., 6: 677-80(July-Aug. 1969).

From International Conference on Thin Films, Boston, Mass. See CONF-690435.

Current-induced and thermally induced flux motion was studied through the flux flow resistivity and the Nernst effect, respectively, in superconducting films of lead, tin, and indium. The film thickness ranged between 0.5 and 11 μ. In addition to the flux flow resistivity and the transport entropy of a fluxoid, the critical current and the critical temperature gradient, at which current-induced or thermally induced flux motion sets in, were determined. The critical current density and thereby the critical Lorentz force were found to increase strongly with decreasing film thickness. Further, with decreasing film thickness the critical Lorentz force became much larger than the critical thermal force. The experiments suggest that in a thin film the critical current is predominantly a surface current and that the critical surface currents contribute only very little to the Lorentz force on a fluxoid. Apparently, at and below its critical value the current flows in such a pattern that there is very little interaction with the fluxoids in the film. (auth)

23913 STRONG-COUPLING SUPERCONDUCTORS, THE MOESSBAUER EFFECT, AND LOCALIZED IMPURITY MODES. Craig, P. P. (Brookhaven National Lab., Upton, N. Y.); Kitchens, T. A.; Taylor, R. D. Phys. Rev., B; 1: 1103-6(1 Feb 1970).

McMillan has recently proposed that in the strong-coupling theory of superconductivity certain expectation values for the lattice eigenfrequencies play a dominant role. It is pointed out here that the Moessbauer effect can measure the important parameter in McMillan's theory in a rather direct fashion. Local-impurity-model calculations assuming isotopic impurities are presented, suggesting that McMillan's parameter is locally enhanced by heavy impurities in light lattices. (auth)

23914 STRONG-COUPLING EFFECTS IN THE PRESSURE DEPENDENCE OF SUPERCONDUCTIVITY. Trofimenkoff, P. N.; Carbotte, J. P. (McMaster Univ., Hamilton, Ont.). Phys. Rev., B; 1: 1136-43(1 Feb 1970).

The effect of hydrostatic pressure on the superconducting properties of the strong-coupling metals Pb and Hg is discussed. The Éliashberg gap equations are solved at zero and at finite pressures to obtain the gap Δ_0 in the excitation spectrum at T = 0 and the critical temperature T_c. The calculations are effected for kernels at zero pressure and repeated with kernels appropriate to a 5% volume decrease. At nonzero pressure the phonon parts of the kernels are rescaled for the upward shift in the phonon frequencies and adjusted for changes in the electron–ion pseudopotential form factor. It is found that Δ_0 and T_c do not scale in the same way under pressure. The gap is relatively more affected, so that the ratio $2\Delta_0/k_BT_c$ tends towards the BCS weak-coupling limit of 3.52 with decreasing volume and, hence, decreasing electron–phonon interaction. In Pb, the results are in good agreement with experiment for both the change in T_c and in the ratio $2\Delta_0/k_BT_c$. In Hg, no experimental results exist at the moment, but similar strong-coupling effects are predicted. (auth)

23915 PURE NUCLEAR QUADRUPOLE RESONANCE IN SUPERCONDUCTING AND NORMAL DOUBLE-HCP ^{139}La METAL. Poteet, W. M.; Tipsword, R. F.; Williams, C. D. (Virginia Polytechnic Inst., Blackburg). Phys. Rev., B; 1: 1265-6(1 Feb 1970).

The $3/2-5/2$ and $5/2-7/2$ pure quadrupole-resonance frequencies for the two inequivalent sites of double hcp ^{139}La metal have been measured in the superconducting and normal states, giving quadrupole coupling constants of 7.700(2) and 6.798(4) MHz in the normal state and shifts of about 0.10 and 0.14%, respectively, in the superconducting state. The asymmetry parameter was experimentally zero. (auth)

23916 COHERENT STATES IN SUPERFLUIDS: THE IDEAL EINSTEIN–BOSE GAS. Johnston, James R. (Dalhousie Univ., Halifax, Nova Scotia). Amer. J. Phys.; 38: 516-28(Apr 1970).

It is argued that the grand canonical ensemble is not appropriate for describing local properties of a closed system when the system has off-diagonal long-range order over distances of the order of the dimensions of the system (e.g., when there is a condensation into a single-particle state). It is shown that the local dispersion in number in the condensed part of an ideal Einstein–Bose gas is "small" (appropriate to a Poisson distribution), contrary to the usual result obtained using the grand canonical ensemble. This leads to an approximation in which the condensed part of the system is represented locally by a coherent state. It is further argued that these considerations serve as a rationale for breaking gauge symmetry whereas the usual arguments (based on analogy with ferromagnetism) are not appropriate. (auth)

23917 CALCULATION OF HYSTERESIS LOSSES IN HARD SUPERCONDUCTORS CARRYING AC: ISOLATED CONDUCTORS AND EDGES OF THIN SHEETS. Norris, W. T. (Central Electricity Generating Board, Leatherhead, Eng.). J. Phys., D (London); 3: 489-507(Apr 1970).

Two methods of calculating hysteresis losses in hard superconductors are described. The London (1963) model is assumed in which the critical current density is taken independent of magnetic field. Losses in isolated wires of different cross section are considered but it is found that losses for solid wires vary by at most a factor of 3 for different shaped wires of the same current-carrying capacity. The loss at saturation current is usually 0.4 to 0.6 $B_c^2\mu_0/\pi$. Losses at the edges of thin sheets are also calculated and a fourth-power dependence on current (for low current) is found. Three systems are examined: a slit parallel to the current in a wide sheet ($L_c \simeq \mu_0 j^2 g^2 \pi^3 F^4/24$), one pair of the edges of two wide strips set back-to-back and carrying antiparallel currents ($L_c \simeq \mu_0 \pi j^2 s^2 F^4/6$) and a long thin wall parallel to the current flow on a wide sheet ($L_c \simeq \mu_0 \pi^3 j^2 a^2 F^4/3$). L_c is the loss per cycle per unit length, F is the current peak as a fraction of saturation current, g the width of the slit, s the spacing of strips, a the height of the asperity and j the critical current density per unit width. All in MKS units. (auth)

23918 NUMERICAL CALCULATION OF THERMAL-NOISE VOLTAGE IN A JOSEPHSON JUNCTION OF FINITE CAPACITANCE. Kurkijaervi, J.; Ambegaokar, V. (Research Inst. for Theoretical Physics, Helsinki). Phys. Lett.; 31A: 314-15(23 Mar 1970).

The Langevin equations governing the thermal voltage across a Josephson junction just below the transition temperature and driven from a constant current source are solved on a computer using a molecular dynamics method. Some representative current–voltage curves so obtained are given and analyzed physically (auth)

23919 DESTRUCTION OF SUPERCONDUCTIVITY IN DISORDERED NEAR-MONOLAYER FILMS. Strongin, Myron; Thompson, R. S.; Kammerer, O. F.; Crow, J. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., B; 1: 1078-91(1 Feb 1970).

Severe decreases are observed in the superconducting transition temperatures of metallic films as they are made thinner and more disordered. Explanations for these decreases in the transition temperature are discussed. These include changes in the phonon spectrum, the effect of the metal–insulator boundary, size quantization in small particles, the effect of an activated conduction mechanism in the normal state, and, finally, the effect of order-parameter fluctuations. (auth)

23920 SUPERCONDUCTING SURFACE SHEATH OF A SEMI-INFINITE HALF-SPACE AND ITS INSTABILITY DUE TO FLUCTUATIONS. Fink, H. J.; Presson, A. G. (Atomics International, Canoga Park, Calif.). Phys. Rev., B; 1: 1091-6(1 Feb 1970).

The surface sheath of a semi-infinite half-space for applied magnetic fields $H_0 \geq H_{c2}$ and Ginzburg–Landau κ values ≥ 0.707 was investigated with regard to its current-carrying capacity and stability. It is found that infinitesimally three-dimensional fluctuations of the order parameter and the vector potential make the surface sheath unstable and the total stable transport current zero. (auth)

23921 SURFACE STATES IN SUPERCONDUCTING INDIUM. Maldonado, J. R. (Bell Telephone Labs., Murray Hill, N. J.); Koch, J. F. Phys. Rev., B; 1: 1031-9(1 Feb 1970).

Measurements of the microwave (10 to 40 GHz) surface impedance of superconducting indium in a magnetic field revealed the distinct peak structure that is associated with the excitation of quantum-mechanical surface-bound quasiparticle states. The impedance peaks are found to depend on frequency and temperature as predicted by the model. A sensitive dependence of the peaks on the surface roughness was discovered that can be understood qualitatively in terms of Pincus's theory of the surface states. Following Garfunkel, calculations of the surface impedance were carried out that correctly give peaks in the impedance derivative at values of magnetic field where the surface electron binding energy equals the microwave photon energy. The calculated peaks have the experimentally observed frequency-temperature scaling. (auth)

23922 BARDEEN–KUEMMEL–JACOBS–TEWORDT THEORY OF A VORTEX NEAR T_c. Cleary, Robert M. (Univ. of Illinois, Urbana). Phys. Rev., B; 1: 1039-43(1 Feb. 1970).

An expression for the free energy of a superconductor containing magnetic flux is derived for temperatures near T_c. To order $T_c - T$, the result is identical to that of Ginzburg–Landau as derived by Gor'kov. A term proportional to $(T_c - T)^{\frac{1}{2}}$ is shown to vanish in perturbation theory. The validity of the variational functions of Bardeen et al. is verified near T_c where the critical value of κ is almost identical to $1/\sqrt{2}$. (auth)

23923 TIME SCALE OF INTRINSIC RESISTIVE FLUCTUATIONS IN THIN SUPERCONDUCTING WIRES. McCumber, D. E.; Halperin, B. I. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 1: 1054-70(1 Feb 1970).

A thermal-activation theory of intrinsic fluctuations in thin superconducting wires has been proposed by Langer and Ambegaokar (LA). Their fluctuation rate equals an exponential activation factor $e^{-\Delta F/k_B T}$ times a prefactor Ω which fixes the fluctuation time scale. Using a model based upon a time-dependent Ginzburg–Landau equation, a new estimate of Ω is obtained which is different in functional form from the LA estimate, and smaller than that estimate by more than 10 orders of magnitude for the conditions in recent experiments. To within corrections which are roughly of order unity, the expression is $\Omega = (L/\xi)(\Delta F/k_B T)^{\frac{1}{2}}/\tau$, where (L/ξ) is the length of the sample in units of the Ginzburg–Landau coherence length ξ, $(\Delta F/k_B T)^{\frac{1}{2}}$ is a correction for overlap of fluctuations at different places along the wire, and $\tau \approx 10^{-8}$ sec is the relaxation time in the Ginzburg–Landau equation. Although the specific expressions have been derived from a time-dependent Ginzburg–Landau theory, it is expected from general physical arguments that they are relatively insensitive to the starting model. (auth)

23924 APPLIED MAGNETIC FIELD-CRITICAL CURRENT DENSITY CHARACTERISTICS FOR SUPERCONDUCTING Nb–40 Zr–10 Ti ALLOY SHEETS. Kitada, Masahiro; Doi, Toshio; Umezawa, Tadashi (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 34: 1-5(Jan 1970). (In Japanese).

Anisotropies in the $H-J_c$ characteristics of the rolled Nb–40 Zr–10 Ti alloy sheets were investigated. $H-J_c$ characteristics of various heat-treated specimens were measured at 4.2°K in a transverse magnetic field. When the rolled plane is parallel to the applied magnetic field, the critical current density is 1.7×10^5 A/cm^2 at 60 kOe. In case the rolled plane is normal to the applied magnetic field, however, the critical current density decreases to about $\frac{1}{3}$ to $\frac{1}{6}$ of the above value. The most suitable treatment to increase the critical current density of the specimens is the intermediate heat treatment at 700°C for 1 to 5 hr. When the rolled plane is fixed parallel to the applied magnetic field and only the angle of the rolling direction to the applied magnetic field is changed, the critical current density of the specimens is not dependent upon the above angle; but, when the rolled plane is normal and the rolling direction is parallel to the applied magnetic field, the critical current density decreases to about $\frac{1}{2}$ to $\frac{1}{3}$ of the value for the specimen whose rolling direction is normal to the applied magnetic field. (auth)

23925 RELATION BETWEEN THE ANISOTROPY OF APPLIED MAGNETIC FIELD-CRITICAL CURRENT DENSITY CHARACTERISTICS AND MICROSTRUCTURES FOR SUPERCONDUCTING Nb–40 Zr–10 Ti ALLOY SHEETS. Kitada, Masahiro; Doi, Toshio (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 34: 5-10(Jan 1970). (In Japanese).

The microstructures and textures of Nb–40 Zr–10 Ti superconducting sheets were investigated to find the relation between the microstructure and the anisotropy of $H-J_c$ (applied magnetic field–critical current density) characteristics and the dependency of the $H-J_c$ characteristics upon the texture were discussed. The source of the $H-J_c$ characteristics is the anisotropic distribution of dislocations and precipitates which are introduced in a stage of heat treatment and rolling, J_c^{min} (rolled plane $\perp$ applied magnetic field) to J_c^{max} (rolled plane//applied magnetic field) ratio in a transverse magnetic field is in proportion to $a/(a+d)$, where a and d are the thickness of the "imperfect layer" and of the "perfect layer" in the section of the specimen, respectively. The dependence of the texture on the $H-J_c$ characteristics is not observed. (auth)

23926 EFFECT OF OXYGEN ON SUPERCONDUCTING CHARACTERISTICS OF Nb–40 Zr–10 Ti ALLOY. Kitada, Masahiro; Doi, Toshio (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 34: 11-16(Jan 1970). (In Japanese).

The effect of oxygen on various properties of superconducting Nb–40 Zr–10 Ti alloy was investigated. The $H-J_c$ (applied magnetic field–critical current density) characteristic in a transverse magnetic field at 4.2°K, the superconducting transition temperature T_c, the microscturture, and the mechanical properties were examined. The results are as follows: (1) J_c of Nb–40 Zr–10 Ti alloys increases with the addition of oxygen. The main reasons for the increase of J_c of the specimens are considered to be the following three. (a) The pinning force that impedes the motion of the flux line increases with the existence of solute oxygen. (b) The interaction between the flux line and the $\beta' + \beta''$ lamella is strengthened by the refining of the $\beta' + \beta''$ structure (aged at 700°C). (c) The $\beta \rightarrow \beta' + \beta''$ reaction is accelerated by the existence of oxygen. The increase in J_c for the specimens aged at 700°C are, therefore, due to more than two reasons mentioned above. (2) T_c of the alloy decreases with the addition of oxygen. (3) The tensile strength and the brittleness of the specimens increase with addition of oxygen. (auth)

23927 SUPERCONDUCTING PROPERTIES OF BCC ALLOYS IN THE Nb–Ti–Mo SYSTEM. Sadagopan, V.; Gatos, H. C.; Olson, G. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys.; 41: 1874-5(15 Mar 1970).

The superconducting transition temperature T_c, critical field H_r, and current-carrying capacity J_c were determined on eight bcc alloys in the ternary Nb–Ti–Mo system. The highest T_c values were observed for an average valence electron concentration of 4.4 to 4.6, and T_c and H_r vary smoothly with composition. A ternary diagram of T_c shows that the addition of Mo to the Nb–Ti binary depresses T_c; however, the mechanical properties are improved. (D.L.C.)

23928 THERMAL CONDUCTIVITY OF SUPERCONDUCTING INDIUM ALLOYS NEAR THE UPPER CRITICAL FIELD. DelVecchio, L. V.; Lindenfeld, P. (Rutgers - The State Univ., New Brunswick, N. J.). Phys. Rev., B; 1: 1097-1102(1 Feb 1970).

The thermal conductivity of several indium–bismuth specimens has been measured as a function of magnetic field and temperature between 0.3 and 4.2°K. The main emphasis is on the region

near the upper critical field, where a linear variation of the electronic thermal conductivity with magnetic field is expected. The experimental results are in good agreement with the calculations of Caroli and Cyrot above a reduced temperature of 0.4, but, below that temperature, the experimental values of the slope are lower than the theoretical values by up to 30%. It is possible to account for the discrepancy by assuming a more rapid variation with temperature of the parameter κ_2/κ than that which is theoretically expected. For the comparison with theory, it was necessary to separate the electronic and lattice conductivities, and to analyze the lattice term into its contributions from the various scattering mechanisms. A correction could then be made for the field variation of the lattice conductivity. From the critical fields, the product of the electronic mean free path and the residual electrical resistivity was determined to be 0.56×10^{-11} Ω cm². The data also lead to a value for the coherence length of indium of 3540 Å. (auth)

23929 DEDUCTION OF SUPERCONDUCTING ENERGY GAPS FROM ULTRASONIC ATTENUATION DATA. Perz, J. M. (Univ. of Toronto). J. Phys., C (London); 3: 438-47(Feb 1970).

The sensitivities of four common methods of analyzing ultrasonic data on superconductors to common systematic errors and to deviations of the data from the Bardeen–Cooper–Schrieffer form are examined. Each method of analysis gives different weights to attenuation data taken at different temperatures. As a result, the methods react differently to various forms of bias introduced either in the experiment or in the analysis. Some of the methods have particular advantages in that their graphical presentation of the data shows clearly the presence of systematic error or bias. (auth) (UK)

23930 EFFECT OF NONMAGNETIC LOCALIZED STATES IN SUPERCONDUCTING ALLOYS. Kaiser, A. B. (Imperial Coll. of Science and Tech., London). J. Phys., C (London); 3: 410-22 (Feb 1970).

The author has calculated in detail the excitation spectrum and superconducting critical temperature for dilute nonmagnetic alloys containing transition-metal impurities, the host metal being an isotropic Bardeen–Cooper–Schrieffer superconductor. The localized d states at the impurity sites are considered to affect the superconductivity due to the resonance scattering interaction as proposed by Zuckermann, and the model of Ratto and Blandin is used to take account of the Coulomb repulsion between d electrons of the opposite spin. It is shown that these alloys are essentially Bardeen–Cooper–Schrieffer superconductors, with an effective coupling constant which decreases approximately linearly with impurity concentration until the superconductivity is quenched. Hence the decrease of the critical temperature and of the energy gap in the excitation spectrum is exponential in the impurity concentration, as suggested by experimental measurements of the critical temperature of Al–Fe group alloys. The calculations reveal clearly the physical origin of the weakening of the superconducting pairing, and it is shown that no region of gapless superconductivity exists. (auth) (UK)

23931 THEORY OF MAGNETIC IMPURITIES IN SUPERCONDUCTORS. II. DEPRESSION OF THE TRANSITION TEMPERATURE. Mueller-Hartmann, E. (Univ. of California, San Diego); Zittartz, J. Z. Phys.; 234: 58-69(1970).

The depression of the superconducting transition temperature due to the pair breaking effect of magnetic impurities is calculated exactly within the Nagaoka–Suhl approach to the Kondo problem in superconductors. (auth)

23932 APPLICATIONS OF SUPERCONDUCTING MAGNETS IN JAPAN. Fushimi, K. (Electrotechnical Lab., Tokyo). Cryogenics; 10: 116-18(Apr 1970).

Recent applications of superconducting magnets in electric power generation and as lenses for charged-particle beams and plasma confinement are described. (auth) (UK)

23933 A STUDY OF THE DESTRUCTION OF SUPERCONDUCTIVITY IN WIRES BY ALTERNATING CURRENT. Totubalin, V. N. (Physical-Technical Inst., Leningrad). Cryogenics; 10: 165-6(Apr 1970).

An oscilloscope arrangement, which simultaneously shows the current through a specimen and the voltage on it, is often used to study the process of destruction of superconductivity by a current. This voltage is composed of the emf from the self-inductance of the specimen and the potential drop along its ohmic resistance. The induced emf from the specimen can be balanced if the measuring and current circuits are connected inductively. A bridge circuit for balancing the specimen self-induction emf is described, in which the magnitude of the compensating emf can be controlled. Compensation of the self-induced emf of the specimen makes it possible to observe the transition process from the superconducting to the normal state under the action of a current pulse in conditions when the induced emf is greater than the voltage drop along the ohmic resistance. (auth) (UK)

23934 HYSTERESIS EFFECTS IN THE SUPERCONDUCTING Pb–In ALLOY SYSTEM. Dubeck, L. W. (Temple Univ., Philadelphia); Aston, D. R.; Rothwarf, F. J. Appl. Phys.; 41: 1593-6(15 Mar 1970).

A method is presented for transforming hysteretic magnetization curves into their corresponding reversible magnetization curves. This procedure permits the determination of the thermodynamic critical field H_c; the lower critical field H_{c1}; the upper critical field H_{c2}; and the Ginzburg–Landau parameters κ_1 and κ_2, which are found to be equal for each corrected magnetization curve for samples containing up to 28 at. % In. Large, composition-dependent, hysteresis effects are noted in the magnetization curves of these Pb–In samples. (auth)

23935 PREPARATION AND PROPERTIES OF SUPERCONDUCTING THIN FILMS OF β-TUNGSTEN STRUCTURE COMPOUNDS. Janocko, M. A.; Gavaler, J. R.; Hulm, J. K.; Jones, C. K. (Westinghouse Research Labs., Pittsburgh). J. Vac. Sci. Technol.; 7: 127-9(Jan-Feb 1970).

From 16th National Vacuum Symposium, Seattle, Wash. See CONF-691006.

Superconducting compounds having the β-tungsten (A15) structure are important materials for use at extremely high magnetic fields. One of these, $Nb_3(Al_{0.8}Ge_{0.2})$, has a superconducting transition temperature of 21 K, the highest known. High purity sputtering techniques developed to prepare Nb–Al–Ge compounds for the first time in the technologically advantageous, thin film form will be described. These techniques included processing of the vacuum enclosure to reach pressures of $\sim 10^{-10}$ torr, sputtering with very high purity argon, and monitoring the impurity level in the system while sputtering by sampling the effluent gas and analyzing it with a quadrupole mass filter. Use of these techniques resulted in the first successful deposition of superconducting Nb–Al–Ge films with the β-tungsten structure, as verified by x-ray diffraction. The properties of these films in magnetic fields up to 220 kOe are discussed in terms of current theory. (auth)

23936 CRYOGENIC TECHNOLOGY. Conference Held in Chicago, June 1967. Weinstock, Harold (ed.). Cambridge, Mass.; Boston Technical Publishers, Inc. (1969). 207p. $18.50. (CONF-670672).

Nine papers are included which treat the following topics: history of cryogenics, thermometry, production and handling of liquid helium, cryostat design, applications in industry and electronics, and superconductivity. A separate abstract was prepared for the paper on superconductivity. (D.L.C.)

For an abstract of one paper see: 23937.

23937 SUPERCONDUCTIVITY STATE OF THE ART FOR POWER APPLICATIONS. Stekly, Z. J. J.; Lucas, E. J. (Avco Everett Research Lab., Everett, Mass.). pp 175-96 of Cryogenic Technology. /Weinstock, Harold (ed.). Cambridge, Mass.; Boston Technical Publishers, Inc. (1969).

From Cryogenic Technology Seminar, Chicago, Ill. See CONF-670672.

Superconducting magnets, once energized, require no power except to maintain the low-temperature environment. Magnetic fields are thus made available that would be otherwise impractical by conventional means because of the large power-generation requirements. Conductors used in constructing superconducting composite magnets consist of the superconductor plus other materials that give the final composite conductor the required mechanical and electrical properties. Wound into a coil, a superconductor experiences disturbances that may seriously affect its performance. The criteria for stable magnet operation are developed. Construction techniques and operating characteristics of typical superconducting coils are cited. (auth)

23938 NMR EVIDENCE FOR IMPURITY-LOCALIZED MAGNETIC MOMENTS IN A TYPE-II SUPERCONDUCTOR. Ducastelle, F. (ONERA, Fontenay-aux-Roses, France); MacLaughlin, D. E.; Rossier, D. pp 379-84 of Magnetic Resonance and Radiofrequency Spectroscopy. /Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From 15th Ampere Colloquium, Grenoble, France. See CONF-680901.

Most of the carbides and nitrides of the second-column transition metals are hard type-II superconductors. Furthermore, transition-metal impurities such as Cr, Mn, or Fe have been shown to possess localized moments when dissolved in some of these compounds, although no moment appears on these impurities when dissolved in the corresponding pure metals. The presence

of moments in the $NV_{1-x}Cr_x$ system is inferred, where x ranges from 0.1 to 1 at. %, from the following results: (1) The superconducting transition temperature T_c decreases rapidly with x. The rate of decrease $-dT_c/dx$ depends on the metallurgical treatment of the samples, and varies between 4 and 8°K (at. %)$^{-1}$. (2) The magnetic susceptibility exhibits Curie–Weiss-like behavior in the normal state. (3) The ^{51}V nuclear spin–lattice relaxation rate, in the superconducting state and below ~2°K, departs from the usual BCS law and tends toward a constant value. This anomalous low-temperature rate is a decreasing function of the external magnetic field, and is thus not attributable to relaxation by the flux vortices. This new nuclear relaxation mode was identified as directly due to the magnetic impurities. The mechanism has been extensively studied in insulating solids doped with paramagnetic impurities, but has not been reported previously for a superconducting metal. (auth)

Plasma and Thermonuclear Physics

23939 (EUR–4268) PLASMA PHYSICS. Linhart, J. G. (European Atomic Energy Community. Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). [Laboratori Nazionali di Frascati]). 1969. 339p. EUR FF 35.

The following chapters are included: (1) motion of electrons and ions in electric and magnetic fields, (2) fluid description of plasma, (3) equilibrium configurations, (4) waves and instabilities in plasma, (5) shock waves in plasma, (6) collision and relaxation processes, (7) research on controlled fusion, and (8) other applications. (M.O.W.)

23940 (NP–18193) WILLS PLASMA PHYSICS DEPARTMENT EIGHTEENTH SIX-MONTHLY PROGRESS REPORT, 1st JULY–30th DECEMBER 1969. (Sydney Univ. (Australia). School of Physics). 9p. (PR–18). Dep. CFSTI (U. S. Sales Only).

Research work carried out at the Sydney University school of Physics during this period is briefly summarized. In particular, the work covered the following areas: (1) plasma sources, (2) hydromagnetic ionizing fronts, (3) hydromagnetic waves in nonuniform magnetic fields, (4) laser diagnostics, and (5) far-infrared. (M.O.W.)

23941 PLASMA PHYSICS INDEX. VOLUME 5, NO. 2, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation(1969). 93p.

This listing includes 386 articles on various aspects of plasma physics. (M.O.W.)

23942 PLASMA EXPERIMENTS IN SPACE. Luest, R. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). pp 39-56 of Recent Advances in Engineering Science. Vol. 4. /Eringen, A. C. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From 5th Meeting on Recent Advances in Engineering Science, Huntsville, Ala. See CONF-671091.

The means of space research have opened new possibilities to study plasma phenomena under conditions not easy or not at all to be realized in a laboratory. For such investigations the plasma present in space, for instance in the ionosphere, magnetosphere, or interplanetary space, can be used. Also, a plasma might be injected into space and its behavior studied, in particular its interaction with the particles and fields present there. Experiments of this kind have been carried out by ejecting barium vapor into the upper atmosphere (around 200 km) and into the magnetosphere (up to 2000 km). The Ba atoms are ionized in a short time by the uv radiation of the sun. In this way electric fields in the upper atmosphere could be measured for the first time. The strength and the direction of the electric fields of intermediate latitudes and in the polar region are discussed. Furthermore, general aspects of these experiments in relation to problems of plasma physics will be considered. (auth)

Confinement and Heating

23943 (CU–3958-3) TURBULENT HEATING OF A PLASMA BY MEANS OF MICROWAVE SCATTERING. Annual Progress Report, April 1, 1969–March 31, 1970. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). Contract AT(30-1)-3958. 15p. Dep. CFSTI.

The experimental apparatus is described. The plasma is generated in two conical pinch guns and is injected along the hexapole guide fields simultaneously into each end of the static magnetic mirror field. The plasma density, before turbulent heating, can be set at 10^{12} to 10^{13} cm^{-3} by varying the injection conditions. Diagnostic instruments and results are described. (M.O.W.)

23944 (NP–18187) TURBULENT HEATING OF IONS IN SKINNED HIGH-FREQUENCY DISCHARGE. Dubovoi, L. V.; Ivanov, B. A.; Chernobrovin, V. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii, Leningrad). 1969. 24p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A corpuscular diagnostics method was used for measuring energy spectra of ions in a strong hf discharge with skin current. The spectra revealed the presence of two groups of ions—the basic one with temperature of ~50 eV, and a small group with T ~ 700 eV, at mean electron temperature in the plasma of ~100 eV. Both groups of ions are described by a Maxwell energy distribution function. Data obtained indicate that the flow of the plasma initial discharge stage is collision-free, but the heating process of electrons and ions is turbulent. Results are in good agreement with the theory predicting plasma heating produced by the excitation in the skin-layer region of the ion–acoustic microinstability. (tr-auth)

23945 (UCRL–71769(Rev.1)) ASTRON PLASMA PARAMETERS CONFINED IN THE CLOSED MAGNETIC WELL OF A PROTON E-LAYER. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Sep 1969. 13p. (CONF-690901–8). Dep. CFSTI.

From International Conference on Nuclear Fusion Reactors, Culham, England.

A relativistic proton E layer of energy of 2 GeV is formed in a 100 kG field. The outer radius of the E layer is approximately 180 cm and its length 800 cm. The combination of the external magnetic field and the field of the proton E layer forms a closed pattern of magnetic lines known as "closed magnetic well" within which plasma is confined. The plasma radius is 125 cm and its length approximately 300 cm. Coulomb interactions of the relativistic protons with the confined plasma can heat the plasma up to a temperature of 10 keV even if the plasma lifetime is limited by anomalous diffusion to 140 Bohm lifetimes. Under the assumption that the energy of the 3.5-MeV α particles produced by D–T fusion reactions is transferred to the plasma it is possible to sustain a plasma of a temperature of 20 keV and density of 2.1×10^{15} ions/cm^3 even if the plasma lifetime is 75 msec or 130 Bohm lifetimes. The plasma diffuses through both ends of the plasma confinement region through the first open magnetic lines. Thus it leaves the plasma confinement area through two plasma streams along the axis of symmetry of the magnetic field configuration. Recently a method of direct conversion of the plasma energy to electric power has been proposed with efficiency upwards of 90%. The resulting electric power (1350 MW) is adequate to provide the power for a relativistic proton accelerator generating 4-GeV molecular hydrogen 250 mA, 1000 MW. The estimated power required to sustain the E layer is approximately 940 MW of relativistic protons. It is proposed to accelerate the protons in an electron ring accelerator. Electrons of several hundred MeV are injected in a static magnetic field to form an electron ring which subsequently is compressed by a properly shaped static magnetic field to a very small diameter. The electron current in the ring is of the order of 50,000 A and its electrostatic field of the order of 6 MeV cm^{-1}. Subsequently, hydrogen ions are trapped. Thereafter the ring is axially accelerated in a decreasing magnetic field carrying the trapped ions, which are accelerated to 4 GeV per charge. The ions are trapped in the E layer by dissociation. Approximately 700 MW of the energy required to sustain the E layer is trapped in the system. Thus the total thermal power released (excluding the plasma losses) is 11,200 MW. The net electric power produced, assuming a 50% efficiency of the power generation plant, is 5600 MW. (auth)

23946 HIGH MAGNETIC FIELD PHYSICS. Lax, B. (Massachusetts Inst. of Tech., Cambridge). pp 52-66 of High Magnetic Fields and Their Applications. London; Inst. of Physics and Physical Society (1969).

From International Conference on High Magnetic Fields and Their Applications, Nottingham, England. See CONF-690939.

Reference is made to the use of magnetic fields of the order of 100 kG and higher as tools for studying the electronic and magnetic structure of solids; these studies have included magneto-optical effects, cyclotron resonance, magnetism, superconductivity, transport phenomena, adiabatic demagnetisation, etc. Other studies have included magnetoplasma–phonon interactions by neutron scattering, properties of high-energy plasmas, etc. The synchrotron radiation of a hot plasma can provide an excellent submillimeter source for spectroscopy. Electron beams in high fields can provide in a storage ring the most intense controllable broad-band uv and x-ray sources known. High fields may also be the key to the nuclear fusion problem, and a high-field toroidal device is mentioned that may provide higher electron and ion temperatures than any of its predecessors. (UK)

23947 TURBULENT HEATING OF IONS IN A SKIN HIGH FREQUENCY DISCHARGE. Dubovoi, L. V.; Ivanov, B. A.; Chernobrovin, V. I. (Scientific-Research Inst. of Electrophysical Apparatus, Leningrad). Zh. Eksp. Teor. Fiz.; 58: 14-25(Jan 1970). (In Russian).

The ion energy spectrum in a high-frequency discharge with a skin current is measured by corpuscular diagnostics techniques. The shape of the spectrum indicates the existence of two groups of ions in the experiments. The main group has a temperature T ~ 50 eV and a smaller group possesses a temperature T ~ 700 eV, the mean electron temperature in the plasma being ~100 eV. Both ion groups can be described by a Maxwellian energy distribution function. An analysis of the results shows that the plasma during the initial discharge stage is collisionless and heating of electrons as well as ions is of a turbulent nature. The results of the experiments are in satisfactory agreement with the theory, which predicts plasma heating due to excitation of ion-acoustic microinstability in the skin-layer region. (auth)

23948 INVESTIGATION OF THE ANOMALOUS RESISTANCE OF A PLASMA DURING TURBULENT HEATING. Kalinin, Yu. G.; Kingsep, A. S.; Lin, D. N.; Ryutov, V. D.; Skoryupin, V. A. Zh. Eksp. Teor. Fiz.; 58: 68-75(Jan 1970). (In Russian).

The dependence of plasma resistance on initial conditions of the experiment during turbulent heating by a current is investigated. The plasma resistance decreases approximately as $n^{-\frac{1}{2}}$ with variation of the concentration between 10^{12} cm^{-3} and 10^{14} cm^{-3}. The resistance does not depend on the magnitude of the confining magnetic field when the strength of the latter varies between 5 and 21 kOe. The ratio of the current velocity to the ion beam velocity is calculated on basis of the experimental results. It changes from 1.5 to 10 on variation of the concentration from 10^{14} cm^{-3} to 5×10^{11} cm^{-3}. The dependences obtained and turbulent heating are explained by assuming excitation of ion-acoustic instability in the plasma by a current. (auth)

23949 ELECTROSTATIC POTENTIAL OF A HOT ELECTRON PLASMA CONFINED IN A MAGNETIC BOTTLE. Finzi, Umberto (CEN-Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 269: 1293-6(22 Dec 1969). (In French).

The autocoherent electrostatic potential established in a plasma made up of two monokinetic beams of ions and electrons confined in a stationary regime in a magnetic mirror configuration is studied. (tr-auth)

Diagnostics

Refer also to abstracts 23045, 24045, and 24046.

23950 (COO-2059-1) NUMERICAL AND ANALYTICAL INVESTIGATION OF NONLINEAR PROPERTIES OF THE VLASOV EQUATION AND OF PLASMAS. Progress Report. Knorr, Georg E. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar 1970. Contract AT(11-1)-2059. 27p. Dep. CFSTI.

The following sections are included: (1) relation between characteristic transform and Hermite expansion; (2) cut-off procedure in transformed velocity space — applications to linear and nonlinear theory; (3) nonlinear program using power transform — comparison between nonlinear and quasilinear theory; (4) nonresonant particle contributions in quasilinear theory; (5) finite-difference scheme for Vlasov's equation; and (6) electron motion for slow processes in plasmas. (M.O.W.)

23951 TIME-AVERAGED DENSITY PROFILE IN THE PRESENCE OF A FINITE-AMPLITUDE HELICAL INSTABILITY. Ventrice, Carl A. (Tennessee Technological Univ., Cookeville). Appl. Phys. Lett.; 16: 283-4(1 Apr 1970).

Time-averaged density measurements are made in an argon plasma in the presence of a longitudinal magnetic field of strength equal to eight times the critical field for a helical instability. Under certain conditions, the positive column is found to be dominated by a finite-amplitude helical instability; and the functional form of the time-averaged density profile is in agreement with the theory of Holter and Johnson. (auth)

23952 MEASUREMENT OF PLASMA ELECTRON DENSITY BY HETERODYNING OF TWO FREQUENCIES IN RING LASER. Stefanov, V. J. (Imperial Coll. of Science and Tech., London). Phys. Lett.; 31A: 277-8(9 Mar 1970).

A method is proposed of measuring the electron density of magnetized plasma by incorporating the plasma in a ring laser cavity. The density is determined by heterodyning the two opposite waves and measuring the beat frequency. The magnetic field and length of the plasma have to be known. (auth)

23953 VOLTAGE DROP ACROSS THE PRE-SHEATH OF A PLANE PROBE. Varey, R. H. (Central Electricity Generating Board, Southampton, Eng.). J. Phys., D (London); 3: 601-6(Apr 1970).

The voltage drop across the pre-sheath which surrounds a Langmuir probe is affected by ion flow. The sheath criterion is used to calculate the voltage as a function of the radial position of a plane probe in a low-pressure positive column. (auth) (UK)

23954 TEMPERATURE ESTIMATES IN A DECAYING LITHIUM PLASMA. Ya'akobi, B.; Avivi, P. (Hebrew Univ. of Jerusalem, Israel). J. Phys., B (London); 3: 405-11(Mar 1970).

The calculated emission coefficient of lithium ionized gas first increases with the temperature to a maximum and then decreases. A maximum in the emitted radiation from exploded lithium wires is observed when the temperature decreases. Thus the two curves of emission can be correlated to yield the temporal variation of the temperature employing merely the uncalibrated readings of a single photomultiplier. The results are consistent with those of other measurements. (auth) (UK)

23955 BOUNDARY CONDITIONS FOR ADSORBING-EMITTING ELECTRODES IN CONTACT WITH SEEDED, DENSE PLASMAS. Sajben, M. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 400-6(Mar 1970).

Adsorption and emission from boundary surfaces can profoundly alter the behavior of plasma-electrode systems, requiring a description that takes into account the physical characteristics of both the plasma and the surface. If the plasma is described in continuum terms, the surface properties enter through the specification of various species densities at the boundary, which strongly depend on the rates of emission of the respective species. Using the desorption-rate expressions of Levine and Gyftopoulous for alkali-metal-coated metal surfaces, a method is proposed to determine boundary conditions for all species densities. The case of an equilibrium plasma confined between two plates is worked out in detail. The results suggest that ion densities could be very high near negatively biased boundaries, which in turn could lead to substantial field enhancement of thermionic electron emission. It is suggested that this mechanism might account for anomalously high currents observed in electrostatic probe studies. (auth)

23956 AN IMPROVED OPTICAL RESONATOR FOR MEASURING TIME-DEPENDENT ELECTRON DENSITIES. Curzon, F. L.; Funk, L. W. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 48: 915-18(1 Apr 1970).

The performance of an optical resonator used for measuring time-dependent electron densities in the collapse phase of a Z pinch was improved by the introduction of a simulated concentric mirror system, which reduces problems due to gradients in the refractive index inherent in the nonconcentric configuration, and by the introduction of a rotating quartz block, which modulates the resonator length, increasing the temporal resolution by a method analogous to the fractional-fringe techniques of conventional interferometry. (auth)

23957 INCOHERENT SCATTERING OF MILLIMETER WAVES BY A PLASMA. Nakach, Roland; Nguyen-Trong-Khoi (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 269: 1150-3(3 Dec 1969). (In French).

An experiment is presented on the incoherent scattering of a millimetric wave (8.6 mm) by a plasma having a density of 5 $(10)^{11}$ e/cm^3. The Doppler broadening of the incident wave spectrum by thermal fluctuations of electrons permits electron temperatures between 16 and 60 eV ($T_e \gg T_i$) to be measured. (tr-auth)

23958 MULTICHANNEL ENERGY ANALYSIS OF THE ION FLUX FROM A THETA PINCH. Becker, Gerhard (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Phys., 234: 6-16(1970).

The ion flux parallel to the axis of a linear theta pinch (p_0 = 10 to 30 μ D_2) is analyzed by a new 10-channel energy spectrometer (E = 1 to 10 keV). Time-resolved energy spectra were measured in each single discharge. It can be shown experimentally that neutral gas, electrons, and magnetic fields considerably influence the flux distribution. The measured energy spectra ($E \lesssim 15$ keV) are broad and have no ion groups. At 10 μ D_2 dn/dE is proportional to $\exp\{-E/\bar{E}\}$ for $E \gtrsim 3$ keV, where $\bar{E} \approx 1$ keV. For 10, 20 and 30 μ D_2 $\bar{E}$ is about equal to the kT deduced from the neutron flux. The time developments of the neutron and ion fluxes (in the range 1 to 10 keV) are correlated. For the initial phase of the discharge the measuring results are incompatible with relaxation by Coulomb collisions. It seems rather, that there is anomalously fast relaxa-

tion due to a microinstability. After the anomalous relaxation the end losses, particularly of the slower ions, continue as a result of Coulomb collisions. This produces increasing distortion of the E distribution with small E, which leads to a second microinstability with loss of energetic ions in particular (probably a loss-cone type). (auth)

23959 ELECTROSTATIC PROBE DETERMINATION OF ELECTRON DENSITY IN MEDIUM-PRESSURE (0.2 TO 28 TORR) DISCHARGE PLASMA OF ARGON. Chen, Sin-li; Chang, Jen-shih; Matsumura, S. (Musashi Inst. of Tech., Tokyo). J. Appl. Phys.; 41: 1711-15(15 Mar 1970).

The validity of electron-density determinations using spherical probe in medium pressure discharge plasmas ($r_p/\lambda_e \sim 0.3$ to 40, where r_p = probe radius, λ_e = electron mean-free path) is examined for density range $N_e = 10^9$ to 10^{11} cm^{-3}. Various collision-dominated probe theories are used to obtain N_e from both electron and ion saturation currents (I_e and I_i). N_e determined from I_e coincide reasonably with those determined from microwave measurement, while N_e from I_i are always greater than those from microwave measurement by a factor of 2 to 100. The discrepancy increases with increasing gas pressure and total discharge current and I_i can not be used for N_e determinations. There is "break" on the ion current characteristics which is the same as that reported in the measurement of very low-density flowing afterglow plasmas ($N_e < 10^8$ cm^{-3}). Explanation is offered in connection with the unusual increase of ion current caused by the release of electrons from the probe surface collisions of metastables and the decrease of regular thermal-motion current because of the short mean-free path condition ($\lambda_e < r_p$). (auth)

23960 INHERENT DIFFICULTIES IN THE USE OF ELECTROSTATIC PROBES IN AN rf PLASMA. Cantin, A. (Centre de Recherches pour la Defense, Valcartier, Quebec); Gagne, R. R. J. Nuovo Cim.; 66B: 193-201(11 Apr 1970). (In French).

The behavior of electrostatic probes in rf-excited plasma was studied. The present data illustrate the perturbing effect of a rf potential drop at the plasma-probe junction, on the I–V characteristics of the probe. An increase of the probe ion current was observed, and the electron temperatures deduced from such characteristics are too high by a factor ranging from 2 to 3. Improvements of the probe and its associated circuit minimize the rf potential drop at the plasma probe junction. This permits valid I–V characteristics to be obtained, as shown by experimental results. (auth)

Kinetics (General)

Refer also to abstracts 23752 and 24203.

23961 (UCRL-Trans-10437) INSTABILITY OF CHARGED-PARTICLE BEAMS IN PLASMA. Nezlin, M. V. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from report IAE-1882. 87p. Dep. CFSTI.

Theoretical and experimental data on the instabilities associated with charged-particle beams in plasmas are reviewed. Results obtained in this study on the well-defined nonlinear effects observed in experiments with high-intensity electron beams in plasma are analyzed. (M.O.W.)

23962 ENERGY LOSSES BY A CHARGED PARTICLE IN AN ISOTROPIC PLASMA LOCATED IN AN EXTERNAL HIGH FREQUENCY ELECTRIC FIELD. Tavdgiridze, T. L.; Tsintsadze, N. L. (Inst. of Physics, Tbilisi, USSR). Zh. Eksp. Teor. Fiz.; 58: 975-8(Mar 1970). (In Russian).

Polarization losses of energy by a charged particle in an isotropic plasma located in an external uhf electric field is considered. It is shown that in weak uhf electric fields the losses grow quadratically with respect to the uhf field amplitude; in strong uhf fields the losses are much smaller and on this basis suppression of proper Langmuir oscillations can be assessed. (auth)

Kinetics (Experimental)

23963 PRESSURE AND ELECTRON DENSITY DEPENDENCE OF THE ELECTRON–ION RECOMBINATION COEFFICIENT IN HELIUM. Berlande, Jacques; Cheret, Michel; Deloche, Robert; Gonfalone, Alain; Manus, Claude (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev., A; 1: 887-96(Mar 1970).

The dependence of the recombination coefficient α of He_2^+ ions and electrons on electron density and gas pressure is measured in helium afterglow plasmas where electron and gas temperatures are equal to 300°K, gas pressure ranges from 10 to 100 torr, and electron density from 10^9 to 5×10^{11} cm^{-3}. Electron density decay measured by microwave interferometry is compared with computer solutions of a continuity equation for electrons which takes into account ambipolar diffusion and recombination effects. One finds $\alpha = \alpha_2 + k_e n_e + k_{He} n_{He}$, where n_e and n_{He} are the electron and neutral densities, respectively, and $\alpha_2 \sim 5 \times 10^{-10}$ cm^3 sec^{-1}, $k_e = (2 \pm 0.7) \times 10^{-20}$ cm^6 sec^{-1}, $k_{He} = (2 \pm 0.5) \times 10^{-27}$ cm^6 sec^{-1}. These values compare satisfactorily with results of theoretical computations for a collisional–radiative recombination mechanism including both collisions with electrons and neutrals. The effect of neutrals is particularly noteworthy as far as future experimental work on weakly ionized gases is concerned. (auth)

23964 SPECTROSCOPIC INVESTIGATION OF SUPERSONIC PLASMA JETS. Goldfarb, V. M.; Ilina, E. V.; Kostygova, I. E.; Lukyanov, G. A. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 108-10(Aug 1969).

Translated from Opt. Spektrosk.; 27: 204-8(Aug 1969).

The populations of the levels of argon and helium atoms in a supersonic plasma jet are measured. The conditions for population inversion to occur are established. The temperature and electron density distributions along the length of the jet are obtained for different pressures. (auth)

23965 ABSORPTION OF RADIATION IN A XENON PLASMA. Bakeev, A. A.; Rovinskii, R. E.; Shirokova, I. P. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 114-16(Aug 1969).

Translated from Opt. Spektrosk.; 27: 215-20(Aug 1969).

Values for the coefficient of continuous absorption were obtained as a function of discharge frequency and discharge temperature by the method of transilluminating a xenon pulse-discharge plasma by a probing beam from a separate pulsed light source, combined with simultaneous measurements of the current density and the concentration of neutral and charged particles in the plasma. It was found that the observed ambiguity in the dependence of the absorption coefficient on current density is caused by a varying number of neutral atoms displaced from the discharge region into the ballast volumes of the lamp. A comparison of the theoretical calculation of photoionizing absorption in xenon with obtained experimental results shows a good agreement in the range 3800 to 6000 Å and a discrepancy between theory and experiment in the red and the ir regions of the spectrum. (auth)

23966 EXPERIMENTS ON THE INTERACTION OF A STRONG ELECTRON BEAM WITH A PLASMA. Boehmer, H.; Raether, M. (Univ. of Illinois, Urbana). pp 489-501 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The experimental setup, which did not employ a longitudinal magnetic field, is described. Other areas studied include: (1) microwave radiation from the unstable plasma, (2) spatial growth of the instability, and (3) incoherent scattering of microwaves by the unstable electron plasma oscillations. (M.O.W.)

23967 EXPERIMENTAL OBSERVATION OF MODE COUPLING NEAR THE ELECTRON CYCLOTRON FREQUENCY. Hopman, H. J.; Cabral, J. (EURATOM–FOM, Amsterdam). pp 503-13 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Measurements of the various properties of a beam–plasma system are discussed. Namely, electron and ion frequencies plus harmonics, and many series of peaks running from the ion plasma frequency up to the electron plasma frequency were measured. Amplitude measurements are described also. (M.O.W.)

23968 PRODUCTION OF A DOUBLE-HUMPED ION VELOCITY DISTRIBUTION FUNCTION IN A SINGLE-ENDED Q MACHINE. Andersen, S. A.; Jensen, V. O.; Michelsen, P. (Risoe Research Establishment, Roskilde, Denmark). Phys. Lett.; 31A: 395-6(6 Apr 1970).

An experimental method of producing a double-humped velocity distribution function for the ions in a Q machine is described. The method is based on charge exchange processes between neutral cesium and the ions in a cesium plasma. (auth)

23969 STARK BROADENING OF TWO NEUTRAL HELIUM LINES IN PLASMAS. Greig, J. R.; Jones, L. A. (Univ. of Maryland, College Park). Phys. Rev., A; 1: 1261-5(Apr 1970).

A reanalysis of the data reported in a previous paper has produced significant changes regarding the accuracy of electron densities measured from the widths of Stark-broadened neutral helium lines. This analysis indicates that, within the experimental errors of ~±15%, electron densities measured from the broadening of the neutral helium lines, λ 5016 Å and λ 3889 Å, agree with those determined from hydrogen H_β. In addition to the previous measurements, shifts of λ 3889 Å are presented and a tentative identification of the forbidden line (2^1S-3^1D, λ 5042 Å) is made. (auth)

23970 INVESTIGATION OF TWO OSCILLATION TYPES IN A BEAM-GENERATED PLASMA. Frankort, F. J. M.; Kwaspen, J. J. M. (Technological Univ., Eindhoven, Netherlands). Appl. Sci. Res. (The Hague); 21: 442-51(Jan 1970).

High-frequency oscillations are observed in a beam-generated plasma subjected to an axial uniform magnetic field. The oscillation frequency is measured as a function of the cyclotron frequency. The system is in a condition just below total glow. The oscillations are classified by comparing the experimental results with theoretical analyses of beam–plasma systems in literature. Two types of oscillation are found. They result from (A) the interaction between the forward plasma wave and the slow space-charge wave of the beam and (B) the interaction between the backward plasma wave and the slow space-charge wave of the beam. The oscillation frequency of type A is practically independent of the cyclotron frequency, whereas the frequency of oscillation B increases linearly with it. For type A oscillations to occur a minimum value of the cyclotron frequency is required. (auth)

23971 MASS-SPECTROMETRIC STUDY OF ARGON AFTERGLOW PLASMAS. Bhattacharya, A. K. (General Electric Lighting Research Lab., Cleveland). J. Appl. Phys.; 41: 1707-10 (15 Mar 1970).

Mass-identified measurements of the time dependence of the density of atomic argon ions in decaying plasmas are reported. The measurements yield a mobility $\mu_0(Ar^+) = 1.55\ cm^2\ V^{-1} \cdot sec^{-1}$ for Ar^+ in argon at a gas temperature of 300°K, and for the rate of conversion of Ar^+ into Ar_2^+, a value of $1.9 \times 10^{-31}\ cm^6\ sec^{-1}$. (auth)

23972 ION CONVERSION IN KRYPTON AFTERGLOW PLASMAS. Bhattacharya, A. K. (General Electric Co., Cleveland). Phys. Rev., A; 1: 1196-1200(Apr 1970).

Mass-identified measurements of the time dependence of the density of krypton ions in decaying plasmas are reported. The measurements show that the conversion of atomic into molecular krypton ions occurs by the three-body reaction $Kr^+ + 2\ Kr \rightarrow Kr_2^+ + Kr$ with a conversion rate of $2.3 \times 10^{-31}\ cm^6\ sec^{-1}$ at a gas temperature of 300°K. The measured value of the mobility of atomic krypton ions in krypton is in agreement with the previously published values. (auth)

23973 MEASURED STARK WIDTHS AND SHIFTS FOR NEUTRAL ATOMIC LINES. Miller, Myron H. (Univ. of Maryland, College Park); Bengtson, Roger D. Phys. Rev., A; 1: 983-90(Apr 1970).

Widths and shifts of Stark-broadened, neutral atomic lines have been measured using a gas-driven shock tube. Stark widths are given for 35 isolated lines or blended multiplets of carbon, oxygen, neon, silicon, phosphorus, sulfur, chlorine, and argon. Shift data are presented for 15 of these features. Electron densities are determined from both H_β profiles and pressure–temperature data. Estimated accuracy is 8–25% for the widths and 15 to 40% for the shifts. Results are compared with theoretical predictions and other measurements. (auth)

23974 EFFECTIVE SELECTION OF ELECTRONS FROM PLASMA INTO VACUUM. Kreindel, Yu. E.; Nikitinskii, V. A. (Tomsk Inst. of Radio Electronics and Electron Technology, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 151-3(1969). (In Russian).

Two types of electron selection into vacuum from plasma in a Penning tube were studied previously by L. A. Gutona et al. (Izv. Vyssh. Ucheb. Zaved., Fiz: No. 12, 130(1968)), electron currents up to 20 A were found. The transmission of such currents with density exceeding 100 A/cm^2 at 1 mm distance at nearly 100 V was possible only in the case in which the negative space charge was replaced by positive ions as a result of the transfer of the charge to the extracting electrode. An attempt was made here of finding the relationship between efficient current selection and the properties of the Penning discharge. Also investigated was the possibility of similar effects with auxiliary discharges of other types or when the auxiliary discharge is replaced by a thermocathode. Results showed that the effective electron selection from plasma into vacuum was not related to the Penning properties or any other auxiliary discharge and can take place always when the gap is of a certain geometry. (R.V.J.)

Kinetics (Theoretical)

23975 (JUL-620-TP) TRANSPORT COEFFICIENT OF AN EQUILIBRIUM-APPROACHING IONIZED MULTITEMPERATURE GAS MIXTURE IN A STATIONARY ELECTROMAGNETIC FIELD. Claassen, H. A. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). Oct 1969. 52p. (In German). Dep. CFSTI (U. S. Sales Only).

Under the assumptions $\lambda_{\alpha f}/l \ll 1$ and $\tau_{\alpha f}/t \ll 1$ ($\lambda_{\alpha f}$ and $\tau_{\alpha f}$ are mean free path and mean free flight time of particles of various gas components; l and t are characteristic length and time for macroscopic changes of the transport magnitudes already considered), the tensor transport coefficients of ionized space-charge-contaminated N-component multi-temperature gas mixtures in a stationary electromagnetic field are given and discussed in the framework of the Boltzmann equation and the degree of 13-moment approximation for equilibrium-approaching distribution functions. The results are applied to the special case of a three-component plasma. (tr-auth)

23976 (MATT-769) ACCELERATION CALCULATION FROM A SCALAR POTENTIAL. Boris, Jay P. (Princeton Univ., N. J. Plasma Physics Lab.). Mar 1970. Contract AT(30-1)-1238. 29p. Dep. CFSTI.

Optimization of large computational-physics codes demands that close attention be paid to both speed and accuracy. During the acceleration calculation for stellar and plasma dynamics, sizeable improvements in both speed and accuracy are possible for no great investment of programming effort. Two aspects of the acceleration calculation, calculation of the acceleration vector field on a grid from the potential specified on that grid and interpolation from the grid to the location of an arbitrarily placed particle, are treated. Although these two aspects of the calculation are discussed from the plasma-physics point of view, the applicability of the new techniques presented here extends to stellar, molecular fluid, and pseudo-fluid calculations using a regular rectangular grid. A 6-point difference formula for finding the acceleration field from the potential is described. This formula symmetrizes the difference-derived anisotropic errors in the acceleration, thus permitting errors in collective modes to be reduced from 1 or 2% in a typical case to $\sim 1/400$ of 1%. A numerical technique for discretized interpolation within the mesh cells is presented to improve the efficiency of the second aspect of the acceleration calculation, the particle force and charge sharing. This is accomplished by subdividing each cell of the spatial grid into a mesh of subcells so that precalculated weights, four for each subcell in two dimensions, can be stored in an auxiliary array for rapid reference. This method thus eliminates recalculation of the interpolation weights for each particle in a large many-body calculation. (auth)

23977 CRITERION FOR THE OPTICAL TRANSPARENCY OF PLASMA. Preobrazhenskii, N. G. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 111-13(Aug 1969).

Translated from Opt. Spektrosk.; 27: 209-14(Aug 1969).

A general formulation of a criterion for the optical transparency of plasma is made, assuming a source with an arbitrary function. Hearn's approach is refined for the evaluation of the limiting optical density of a nonequilibrium plasma layer which isolates the transparency region for an atomic spectral line. Two Balmer lines are used as an example to show the effect of going beyond the limitations of the two-level approximation. A "natural" criterion is established for the optical transparency of ionic spectral lines. (auth)

23978 INDUCED RANDOM WALK IN A PLASMA. Puri, S. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 31A: 231-2(9 Mar 1970).

A method is suggested for inducing a selective diffusion of electrons in a magnetoplasma. This mechanism can be used to remove excess electrons from the plasma and make it truly neutral. In this fashion one can study the role played by ambipolar electric fields in the anomalous radial losses. (auth)

23979 STATISTICAL MECHANICS OF A PARTIALLY IONIZED HYDROGEN PLASMA. Theimer, O. (New Mexico State Univ., Las Cruces); Kepple, P. Phys. Rev., A; 1: 957-65(Mar 1970).

A generalized Saha equation for a partially ionized hydrogen plasma is derived and used for calculating the degree of ionization and the effective ionization potential for a wide range of electron densities and temperatures. The energy eigenvalues of the hydrogen atom in a plasma are obtained as solutions of the Schroedinger equation from a shielded potential w(r). w(r), determined by a self-consistent-field method, is found to be completely different from the Debye potential. A strong effect of the excited states at high temperatures is also established. (auth)

23980 CALCULATION OF CURRENT CORRELATIONS IN CLASSICAL FLUIDS VIA MODELED KINETIC EQUATIONS. Duderstadt, J. J.; Akcasu, A. Z. (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 1: 905-14(Mar 1970).

In an earlier paper, the generalized Langevin approach of Mori and Zwanzig was applied to generate an exact kinetic equation describing the time correlation of fluctuations in the microscopic phase density for a classical many-body system. In the present

work, this kinetic equation is modeled using a single-relaxation-time form for the damping kernel, and the solution of this equation is then studied for large and small values of k and ω. The modeled kinetic equation is used to calculate transverse and longitudinal current-current correlations in simple classical liquids, and the results are compared with the molecular-dynamics calculations of Rahman for argon-like systems. (auth)

23981 RESONANCE CONE STRUCTURE IN WARM ANISOTROPIC PLASMA. Fisher, R. K.; Gould, R. W. (California Inst. of Tech., Pasadena). Phys. Lett.; 31A: 235-6(9 Mar 1970).

A fine structure is observed near the resonance cones in the field pattern of a small rf probe and is shown to result from an interference between a fast electromagnetic wave ($v_{group} \sim c$) and a slow plasma wave ($v_{group} \sim v_{th}$). (auth)

23982 RADIATION FROM THE TWO-STREAM INSTABILITY. Ignat, D. W.; Hirshfield, J. L. (Yale Univ., New Haven). Phys. Rev., A; 1: 872-7(Mar 1970).

Coupling between longitudinal and transverse waves is examined for an unbounded homogeneous cold plasma in which the several plasma constituents are in relative drift with respect to one another. For mutual relativistic streaming along the direction of a homogeneous dc magnetic field B, a dispersion relation is derived. For the special case of two equal counterstreaming electron beams, the extraordinary wave-dispersion law is compared with Lee's nonrelativistic result. For B = 0, the dispersion relation is analyzed in some detail, especially as regards the polarization of the unstable eigenmode, and compared with results of Neufeld. It is shown, both analytically and numerically, that radiation effects are relatively insignificant, except for highly relativistic streaming velocity and for a beam–plasma frequency comparable to that of the background plasma. (auth)

23983 ELECTRODYNAMICS OF PARTICLES AND PLASMAS. Clemmow, P. C.; Dougherty, J. P. Addison-Wesley Series in Advanced Physics. Reading, Mass.; Addison-Wesley Publishing Company, Inc. (1969). 465p.

The following chapters are included: (1) electrodynamics, (2) Cherenkov and gyro radiation, (3) dynamical motion of a point charge, (4) waves in an ionized gas—magneto-ionic theory, (5) plasma streams, (6) Boltzmann's equation, (7) waves in ionized gases—kinetic theory, (8) microinstabilities, (9) derivation of magnetohydrodynamics, and (10) kinetic equations for plasmas. (M.O.W.)

23984 CASE FORMALISM FOR SINGULAR NORMAL MODES OF THE VLASOV–BGK EQUATION. Vojta, G.; Mocker, M. (Deutsche Akademie der Wissenschaften, Leipzig. Humboldt Univ., Berlin). Phys. Lett.; 31A: 243-4(9 Mar 1970).

A generalized Case formalism is developed for the singular normal mode solution of the linearized Vlasov equation with complete Bhatnagar–Gross–Krook collision integrals for a nonrelativistic nondegenerate isothermal electron gas with neutralizing ions and neutral particles. The key of the method given is the introduction of a transformed distribution function containing an integral over the usual distribution function. (auth)

23985 NONLINEAR DIELECTRIC TENSOR FOR RELATIVISTIC VLASOV PLASMAS. Golden, K. I. (Northeastern Univ., Boston); Silevitch, M. B. Phys. Lett.; 31A: 329-30(23 Mar 1970).

Second-order perturbation theory calculations are presented for the quadratic conductivity and dielectric tensors of relativistic Vlasov plasmas in self-consistent electromagnetic fields. (auth)

23986 HOLTSMARK-CONTINUUM MODEL FOR AN IONIZED GAS. Dalenoort, G. J. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Phys. Lett.; 31A: 285-6(23 Mar 1970).

The Holtsmark model for a plasma is suitable to account for discrete-particle effects in a plasma without interactions. The continuum model is suitable to account for collective interactions. The outlines for a combined model are given. (auth)

23987 EXCITATION AND IONIZATION OF ATOMS AND IONS IN A NONTHERMAL PLASMA. I. POPULATIONS OF EXCITED LEVELS. Suckewer, S. (Inst. of Nuclear Research, Swierk, Poland). J. Phys., B (London); 3: 380-9(Mar 1970).

Formulae are presented for the populations of levels of excited atoms and ions of a plasma in nonthermal equilibrium over a wide range of electron densities. The validity of the method presented is established by comparison of the calculated population of excited levels of hydrogen-like ions with the results of McWhirter and Hearn (1963). For illustration, the population of excited levels of CII ions are calculated. On the basis of this method the partition function for hydrogen-like ions in a nonthermal plasma was obtained. (auth) (UK)

23988 EXCITATION AND IONIZATION OF ATOMS AND IONS IN A NONTHERMAL PLASMA. II. IONIZATION EQUILIBRIUM. Suckewer, S. (Inst. of Nuclear Research, Swierk, Poland). J. Phys., B (London); 3: 390-8(Mar 1970).

On the basis of the formulae presented in part I (previous paper), defining the populations of excited levels, formulae are derived in this part that determine the degree of ionization of atoms and ions in a nonthermal plasma. These transform into the Saha formula for relatively high electron densities. In conjunction with the partition function derived for a nonthermal plasma, a general formula was obtained which determines the degree of population of excited levels and also the degree of ionization of atoms and ions over a wide range of electron densities. The validity of the method presented was established by comparison of our results with those of Bates et al. (1962) for the ionization equilibrium of hydrogen-like ions. The paper includes the results of calculations of the degree of ionization of ions C II as a function of electron density and temperature. The possibility of using the method was also presented for a nonstationary plasma. (auth) (UK)

23989 TRANSITORY REGIME IN A PLASMA. Pozwolski, Alexandre Edgar (Faculte des Sciences, Paris). Compt. Rend., Ser. B; 269: 1289-92(22 Dec 1969). (In French).

Given some particles distributed according to the Boltzmann function in a conservative force field, the necessary time constants for arriving at equilibrium after a small variation of the potential are found. The theory is applied to a positive-ion sheath with a thickness greater than the mean free path. (tr-auth)

23990 NOTE ON THE TIMES CHARACTERISTIC ON THE MOTION OF MAGNETIC LINES OF FORCE. Sakurai, Kunitomo (Kyoto Univ.). J. Geomagnet. Geoelec.; 20: 281-3(1968).

An expression for the current density in a cold plasma in electric and magnetic fields is given. The plasma velocity perpendicular to the magnetic field gives the moving velocity of magnetic lines of force, in general. The characteristic time for this velocity to reach a constant value is analyzed theoretically. (M.O.W.)

23991 COLLISION COEFFICIENTS IN PLASMA AND EQUILIBRIUM RELATIONS. Froehlich, G.; Sewing, K. H. (Univ., Stuttgart). Z. Phys.; 234: 42-57(1970).

The relation between the collision coefficients of a reaction and the inverse reaction is calculated for nonequilibrium processes for any kind of distribution functions and cross sections. In the case of equilibrium, this relation equals the Maxwell–Boltzmann factor for transitions between discrete levels, and the Saha expression for transitions between free and discrete levels. In case of nonequilibrium, the relation is a middle-value expression, depending on the distribution function of electrons. If this is Maxwellian, the middle value expression does not depend on cross sections. For high electron densities data of the plasma approach to equilibrium values though radiation processes are still efficient. The reasons are discussed. (auth)

23992 NONLINEAR EFFECTS IN PLASMAS. Proceedings of the Second Orsay Summer Institute. Kalman, G.; Feix, M. (eds.). New York; Gordon and Breach Science Publishers Inc. (1969): 527p. $34.50. (In English and French).

Separate abstracts were prepared for the 20 papers included. (M.O.W.)

For abstracts of individual papers see: 23875, 23966, 23967, 23993–24001, 24017–24020, and 24094–24097.

23993 A MINIMUM ENERGY PRINCIPLE IN PLASMA PHYSICS AND STELLAR DYNAMICS. Feix, M. (Langley Research Center, Hampton, Va. Coll. of William and Mary Williamsburg, Va.); Hohl, F.; Staton, Leo. pp 3-19 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The following topics are discussed: (1) steady-state solution of the Vlasov equation, (2) the water bog, (3) energy considerations—minimum energy, and (4) computer experiments. (M.O.W.)

23994 ON A DERIVATION OF THE QUASI-LINEAR EQUATIONS. Trocheris, Michel (EURATOM–CEA, Fontenay-aux-Roses, France). pp 85-93 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Longitudinal waves are considered in an infinite homogeneous plasma without magnetic field, in which the ions are replaced by a uniform background of positive charge. The equations are analyzed in the Vlasov approximation. Adiabatic solutions were found for the equation. (M.O.W.)

23995 MATHEMATICAL MODELS OF PLASMA. Feix, M. (Langley Research Center, Hampton, Va. Coll. of William and Mary, Williamsburg, Va.). pp 151-96 of Nonlinear Effects

in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Two aspects of the numerical work related to plasma problems are discussed. The solution of the nonlinear Vlasov equation through analytical and numerical methods is presented. Also, computer experiments on numerical calculations are presented. (M.O.W.)

23996 CASCADE MECHANISM IN WAVE-MIXING PROCESSES OF TURBULENCE. Tchen, C. M. (City Coll., New York). pp 197-214 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

A locally homogeneous and stationary turbulence in an incompressible fluid is considered. Using the Navier–Stokes equation for the Fourier components of the velocity field, a sequence of equations for moments, or correlations, of the velocity field is derived. In addition, if the turbulent flow carries a concentration, the coupling between the velocity and the concentration gives rise to new correlations, governed by a second sequence of equations. The spectra of turbulence and concentration in flows or without mean gradients are derived. (M.O.W.)

23997 SPECTRUM OF TURBULENCE IN A PLASMA WITH A STRONG MAGNETIC FIELD. Tchen, C. M. (National Bureau of Standards, Washington, D. C.). Contract R-127. pp 233-50 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

A theory for turbulence and turbulent diffusion is given. The diffusive turbulent transport and the cascade process for wave–wave interaction is described, and the "eddy diffusivity," a concept proposed in the Heisenberg theory of hydrodynamic turbulence, is generalized to include plasma diffusion. After having derived the integral equation for the development of density spectral function, the equilibrium solution for the inertial and dissipative ranges is investigated. An expression for the turbulent diffusion is given. The results obtained from the integral equation of the spectral function are compared with those from the similitude theory. (M.O.W.)

23998 EFFECTS OF AN ALTERNATING ELECTRIC FIELD ON A WEAKLY IONIZED GAS: PRODUCTION OF HARMONICS. Delcroix, J. L.; Pointu, A. M. (Faculte de Sciences, Orsay, France). pp 251-85 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969). (In French).

A theoretical study was made for both homogeneous and inhomogeneous weakly ionized gases. The effects of gas temperature and electric field frequency are studied in particular. (M.O.W.)

23999 A COLLECTIVE APPROACH TO THE KINETIC THEORY OF PLASMAS. Ichikawa, Yoshi H. (Faculte des Sciences, Orsay, France). pp 287-307 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The kinetic theory of an unstable plasma was studied on the basis of the Bogolyubov–Born–Green–Kirkwood–Yvon (BBGKY) hierarchy of the system with the Coulomb interaction between particles. A rigorous derivation of the Pines–Schrieffer equations is also given. (M.O.W.)

24000 STRONG TURBULENCE IN COLLISIONLESS PLASMAS. Pfirsch, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). pp 309-33 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The following topics are discussed in relation to strong turbulence: (1) nonlinearities in different plasma equations, (2) semi-empirical methods—the mixing length theory, and (3) the Hamilton–Jacobi theory. (M.O.W.)

24001 NONLINEAR DIELECTRIC FUNCTION AND FLUCTUATIONS OF A PLASMA SUBMITTED TO AN ELECTRIC FIELD. Coste, J. (Faculte des Sciences, Orsay, France). pp 377-86 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

A classical derivation is given of the nonlinear dielectric function (and of the nonlinear propagators), using an iterative solution of the Vlasov equation. Then, considering an electron–ion plasma in thermodynamic equilibrium, an expression was derived for the dominant term of the induced fluctuations, in terms of the nonlinear dielectric function. (M.O.W.)

24002 CLASSICAL SELF-CORRELATION FUNCTIONS IN NONCOLLISIONAL PLASMAS IN A MAGNETIC FIELD. Weil, J. W. (Univ. of Innsbruck). Acta Phys. Pol.; A37: 471-3(1970).

The classical two-particle self-correlation function as introduced by Van Hove and Sunakawa is derived for a plasma immersed in a magnetic field; collisions are neglected. It is discussed for $\omega t \ll 1$ and $\omega t = \pi/2$, and its connection with scattering problems is stressed. (auth)

24003 ANALYSIS OF THERMAL INDUCTION PLASMAS DOMINATED BY RADIAL CONDUCTION LOSSES. Eckert, H. U. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 41: 1520-8(15 Mar 1970).

The energy balance equation is applied to induction plasmas in thermal equilibrium. Approximate, iteration-type, solutions are obtained for cases where heat losses by radiation, axial conduction, and convection can be disregarded. It is assumed that the electric conductivity rises in proportion to the heat conduction potential and that the radial distribution of the induced electric field can be represented by a power law. Under these conditions, the equation can be transformed into Bessel's equation and solved for the heat conduction potential. With a uniform field, the solution reduces to that for a dc arc. The condition of vanishing temperature at the enclosing wall establishes an eigenvalue for the induced electric field at the circumference. Absolute temperature distributions can be calculated as a function of gas properties and applied conditions. It is shown that the latter are given by the time rate of change of primary magnetic flux through the discharge section. The method is applied to argon plasmas at atmospheric pressure. For these plasmas, optimum conversion of magnetic energy into heat should occur at a primary flux rate of 48 V. This value is lowered by the secondary current in the plasma to an actual burning voltage of 32 V. Both values are independent of driving frequency and plasma radius. Skin depth ratio and conversion efficiency at the optimum point agree closely with the values known from induction heating of metals. Experimental data indicate that the discharge has a tendency to operate near this point. Comparison of temperature distributions obtained by this method with exact computer solutions shows that the axis temperature is overestimated by about 15%, but the general shape of the profile is well approximated. (auth)

24004 ANALYTICAL TREATMENT OF RADIATION AND CONDUCTION LOSSES IN THERMAL INDUCTION PLASMAS. Eckert, H. U. (Aerospace Corp., El Segundo, Calif.). J. Appl. Phys.; 41: 1529-37(15 Mar 1970).

Approximate solutions have been obtained of the Elenbaas–Heller equation for a two-zone model of thermal induction plasmas. Most of the heat production takes place in the external zone, where it is kept in balance by conduction losses. The major portion is lost to the wall, the minor transferred to the internal zone. This heat supply accounts for most of the radiation losses, which are confined to the internal zone. A small fraction of radiation is balanced by direct dissipation. Under these conditions, the distribution of the heat conduction potential assumes a parabolic shape for the inner zone, whereas it is described by Bessel functions in the external zone. A coordinate transformation in this zone accounts for the nonuniformity of the induced electric field and explicitly shows the effect of skin depth upon the profile shape. Matching of the zonewise solutions yields temperature distributions that are continuous to the first derivative and display the characteristic minimum at the axis known from experimental work. Generalized charts are presented by which a particular profile can be calculated from the gas transport properties and the time rate of change of primary magnetic flux. The method is applied to argon plasmas at atmospheric pressure with radiation properties calculated from atomic theory. Simple expressions are derived for the total radiated power and the radiation efficiency of the discharge by a further idealization of the model. They indicate that, at most, 50% of the input power can be converted into radiation as long as the discharge remains attached to the tube wall. It is also shown that large field penetration depth improves the efficiency. The results are in qualitative agreement with available experimental data. A quantitative check will require more complete experiments. (auth)

24005 CHARGE SEPARATION IN A QUASI-NEUTRAL PLASMA BY APPLICATION OF AN EXTERNAL VOLTAGE. Schwab, H. A. (Naval Weapons Lab., Dahlgren, Va.). J. Appl. Phys.; 41: 1508-11(15 Mar 1970).

The application of an electric voltage to two electrodes between which a quasi-neutral plasma is contained results in charge transport and charge separation in the plasma. In this paper, the charge distribution, field distribution, and current density in the plasma resulting from the application of a monotonously increasing voltage are computed. The solution is derived under the assumption that the current in the plasma is essentially ion and electron current, and that displacement current can be neglected. (auth)

24006 PHOTON ABSORPTION AND EMISSION FROM NON-EQUILIBRIUM PLASMA OF FINITE VOLUME WITH DOPPLER

BROADENING OF SPECTRAL LINES. Chelnokov, M. B. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 54-9(1969). (In Russian).

Photon absorption in a plasma of finite volume as a model in spherical geometry was studied. Radiation of plasma confined in a cylindrical volume was obtained in approximation of two hemispheres. (tr-auth)

Production

Refer also to abstract 24081.

24007 (NYO-3578-11) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Semiannual Report, January 1, 1969-July 31, 1969. Haught, Alan F.; Polk, Donald H.; Woo, James C.; Fader, Walter J. (United Aircraft Corp., East Hartford, Conn. Research Labs.). 31 Jul 1969. Contract AT(30-1)-3578. 89p. (UARL-H-920365-11). Dep. CFSTI.

An experimental and theoretical investigation was made of the production of high-temperature, high-density, spherically expanding free plasmas and the interaction of these plasmas with magnetic containment fields of mirror and minimum-B geometry. The plasmas in these experiments are produced at the center of the magnetic containment field by irradiation of an electrically suspended, micron-sized solid particle with the focused beam of a Q-switched laser. Hydrodynamic and simplified integrated similarity models of the free plasma formation and development have been developed and give results for the plasma energy in good agreement with experimental measurements. Theoretical studies using the hydrodynamic model have examined the early plasma-magnetic field interaction and show plasma deceleration, trapping and thermalization within the confining magnetic fields. Experimental studies of the interaction of the initially spherical, expanding, laser-irradiated solid particle plasmas with magnetic confinement fields of mirror and minimum-B geometry at field strengths up to 8 kG confirm the results of these calculations, which show that the initial expansion of the hot plasma can be slowed, resulting in plasma trapping at $\beta \approx 1$ (that is, at a pressure comparable with the pressure of the confining magnetic field) and that, upon capture, the plasma expansion energy is thermalized to produce a high-temperature, contained plasma. Charge collector, microwave, retarding potential, and comb-probe diagnostics all give the result that the trapped laser-produced plasma can be contained in a minimum-B magnetic field of 5 kG or greater for a time limited only by Coulomb scattering into the containment field mirror loss cones. The Coulomb scattering loss mechanism of the plasma decay is further supported by mass spectrometer studies which show rapid escape of the highly ionized lithium followed by a more gradual decay of hydrogen and by the $\sim T^{\frac{3}{2}}$ temperature dependence of the plasma lifetime over the factor-of-three temperature range examined experimentally. The results summarized above are outlined in somewhat greater detail along with the supporting evidence from which they are derived. A full discussion of the experimental and theoretical program is presented in appendices. These appendices, which are papers submitted for publication, describe the complete laser-produced plasma program of the United Aircraft Research Laboratories and include the Corporate-sponsored research effort, the free plasma expansion studies, as well as the investigations of the deceleration, trapping, and containment of these plasmas in mirror and minimum-B magnetic fields. Recent results on the long-time confinement of higher-energy plasmas (~100 eV plasmas contained at a density $\geq 3 \times 10^{13}$ cm^{-3} for a Coulomb decay time of 100 μsec) and flux coil measurements of the plasma–magnetic field interaction are also presented. (auth)

24008 METHOD OF PRODUCTION, ACCELERATION AND INTERACTION OF CHARGED-PARTICLE BEAMS AND DEVICE FOR THE EXECUTION OF SAID METHOD. Bardet, Rene; Geller, Richard; Jacquot, Bernard; Consoli, Terenzio. (to Commissariat a l'Energie Atomique). British Patent 1,183,473. 4 Mar 1970. Priority date 11 Mar 1966, France.

The invention is directed to a method of production, acceleration, and confinement of an ionized gas, and further relates to devices for application of the method. Resonant cavities operating in various TE modes are employed. (M.O.W.)

Stability

24009 (CEA-CONF-1397) DYNAMICAL STABILIZATION OF A CONFINED PLASMA. Samain, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1969]. 4p. (CONF-690803-28). Dep. CFSTI (U. S. Sales Only).

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The stabilization of a magnetically confined plasma by an oscillating electromagnetic field has been studied previously using microscopic equations. A formalism suitable to this type of study is presented in this paper for a collisionless low-β plasma. (M.O.W.)

24010 (NP-18188) STUDY OF INSTABILITIES IN HIGH-FREQUENCY ELECTRIC DISCHARGES. Soum, Jean (Toulouse Univ. (France)). 1970. 129p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

In plasmas created by a high-frequency electric field, comparisons were made between electron temperature experimental measurements and previsions deduced from a simplified theory. The influence of metastable neutral atoms on the plasma ionization, the values of the electron temperature, and its variation with pressure and hf electric field were deduced from these comparisons. Then, the intensity, frequency, and structure of the instabilities arising in the plasma were studied. They depend on the electron temperature. It was shown that the plasma can maintain either ionic oscillations or pseudo-acoustic waves and drift waves when the discharge takes place in a magnetic induction. These waves can be excited by currents of electrons oscillating in the hf field and drifting in the plasma. (France)

24011 (UCRL-Trans-1402) LONGITUDINAL INSTABILITIES IN CIRCULAR CHARGED BEAMS. PART I. EFFECT OF NEGATIVE MASS. Bonch-Osmolovskii, A. G.; Perel'shtein, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by T. Watt for Lawrence Radiation Lab., Berkeley, Calif., from report JINR-P9-4424. 17p. Dep. CFSTI.

The stability of an electron ring placed in an infinitely long, perfectly conducting circular tube was analyzed (finite conductivity and the associated resistive instabilities can also be taken into account in this method). (M.O.W.)

24012 PLASMA INSTABILITY IN THE FIELD OF A WEAK TRANSVERSE WAVE. Kirii, A. Yu. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 58: 1002-6(Mar 1970). (In Russian).

Instability of a plasma located in the electromagnetic field of a transverse wave is studied with respect to buildup of nonpotential high-frequency oscillations possessing a frequency close to the frequency of the external wave. The threshold value of the external field strength is found, and the maximum of the increment after the buildup threshold is determined. (auth)

24013 INVESTIGATION OF PLASMA INSTABILITY IN A STRONG ALTERNATING ELECTRIC FIELD. Grigor'eva, L. I.; Smerdov, B. I.; Stepanov, K. N.; Chechkin, V. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 45-50(Jan 1970). (In Russian).

The frequency spectrum is obtained for the previously discovered high-frequency small-scale instability excited in a plasma by a high-amplitude fast magnetosonic wave. The dependence of noise amplitude on field strength of the wave is investigated and it is shown that the dependence is of the threshold type. (auth)

24014 INVESTIGATION OF THE INSTABILITY OF A PLASMA IN A MIRROR TRAP. Kanaev, B. I.; Yushmanov, E. E. Zh. Eksp. Teor. Fiz.; 58: 88-96(Jan 1970). (In Russian).

The ion-cyclotron instability observed in the PR-5 installation differs in many respects from instabilities of the same type encountered in experiments with other mirror traps. This implicates a principally different nature of this instability. In this work the most characteristic feature considered is the wave structure of the unstable oscillations; in particular an attempt is made to answer the question whether the oscillations are transverse of possess $k_{||} = 0$. The method employed for this purpose is based on a determination of orientation of external magnetic fields of the wave and their phasing relative to the electric potential wave. For $k_{||} = 0$ a characteristic feature is the presence of a specific effect related to longitudinal nonuniformity of the plasma cluster. The results are in accordance with those which one would expect for transverse oscillations. The transverse character of the oscillation indicates that instability in PR-5 does not refer to the Harris type as in case of mirror traps with external injection of neutral particles. Apparently one must also reject the explanation of instability predicted earlier as a result of buildup of transverse oscillations by the drift mechanism or as a result of the non-Maxwellian nature of the distribution function since the observed value of the parameter $k\rho_i$ is too small for this. The most probable seems to be the explanation proposed recently by Kadomtsev and Pogutse (Novosibirsk Conference, 1968) according to which the phenomena observed are negative mass instabilities. (auth)

24015 INSTABILITY OF SPATIALLY SEPARATED PLASMA BEAMS, Romanov, Yu. A.; Dryakhlishin, V. F. (Gorky State Univ., USSR). Zh. Eksp. Teor. Fiz.; 58: 348-53(Jan 1970). (In Russian).

The interaction and instability of two spatially separated homogeneous semi-infinite plasma beams are investigated in the kinetic and quasi-hydrodynamic approximations. The interface between the beams is assumed to be sharp and their temperatures identical. The boundaries of beam instability and the wave increments as well as the nature of behavior of the excited wave field are determined. The dependence of the minimal drift velocity, at which oscillations arise, on the collision frequency in the plasma is investigated. It is shown that the wave increments may be quite large and comparable with the corresponding quantities for mutually penetrating beams. (auth)

24016 A TENTATIVE EXPLANATION OF THE SUPPRESSION OF SOME PLASMA INSTABILITIES BY FLOATING WALLS. Geller, R. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Lett.; 31A: 263-4(9 Mar 1970).

A heuristic explanation is given for this effect by means of hindrance of a positive feedback. (M.O.W.)

24017 EXPERIMENTS AND THEORY ON TURBULENCE IN A HIGH-CURRENT DISCHARGE. Robinson, D. C. (Culham Lab., Abingdon, Eng.). pp 21-55 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Theoretical and experimental studies were made of the fluctuations of the hot magnetized plasma in the ZETA device. The principal topic studied was magnetohydrodynamic turbulence in the presence of a strong magnetic field; this leads especially to the problem of two-dimensional turbulence. Taylor microscales, electric and magnetic field fluctuations, and two-dimensional turbulence were studied. (M.O.W.)

24018 STRONG TURBULENCE. Edwards, S. F. (Univ. of Manchester, Eng.). pp 57-83 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Efforts to study strong turbulence in normal liquids are briefly reviewed. Weak turbulence, MHD turbulence, time-dependent correlation functions, and related problems are discussed. (M.O.W.)

24019 PARAMETRIC AND RAMAN INSTABILITIES OF A PLASMA IN AN ELECTROMAGNETIC FIELD. Goldman, Martin V. (Ecole Normale Superieure, Paris). pp 335-61 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Plasma instabilities in an electromagnetic field are discussed in terms of the following: (1) Maxwell equations, (2) review of linear theory, (3) fluctuations and incoherent scattering, (4) stimulated incoherent scattering; and (5) parametric amplification of plasma waves. (M.O.W.)

24020 FINITE AMPLITUDE INSTABILITIES IN WEAKLY IONIZED GASES AND SOLIDS. Johnson, Roy R. (Boeing Scientific Research Labs., Seattle). pp 387-450 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The theory of the helical instability in gaseous and solid-state plasmas is investigated. The perturbation theory is described for weakly ionized gases, and is then extended into the finite-amplitude regime. Finally, the theory of helical instability in solid-state plasmas is presented. (M.O.W.)

24021 EFFECT OF TRAPPED PARTICLES ON THE DRIFT-CYCLOTRON INSTABILITY IN A MULTIPOLE. Bhadra, Dilip K. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., A; 1: 1201-07(Apr 1970).

The effect of trapped particles on the drift-cyclotron instability in a multipole machine has been considered. Dispersion equations have been obtained for this instability in a nonuniform collisionless plasma using a simplified approach which takes into consideration the magnetic field strength and curvature variation along field lines. The results show the existence of a branch of oscillations with frequency $|\omega| \sim \Omega_0 - k\bar{v}_g - \bar{\omega}_b$, where Ω_0, $\bar{v}_g$, and $\bar{\omega}_b$ are the average gyrofrequency, the drift velocity due to magnetic field gradient, and the ion "bounce" frequency, respectively, with k being the wave vector transverse to the magnetic field. This may explain the discrepancy between the experimentally observed frequency and the theoretical value obtained previously. This branch of the oscillation also shows a larger growth rate. (auth)

24022 POSSIBLE EXPLANATION FOR THE OBSERVED SELF-EXCITED SUBHARMONICS OF A CURRENT-CONVECTIVE INSTABILITY. Keen, B. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett.; 31A: 357-8 (6 Apr 1970).

A possible explanation is given for the recently observed subharmonics (at $\frac{1}{2}\omega_0$, $\frac{1}{3}\omega_0$, $\frac{1}{4}\omega_0$, etc.) generated spontaneously by the self-excited current-convective instability (ω_0) of a magnetoplasma. (auth)

Thermonuclear Processes

24023 (EUR-CEA-FC-539) NEW $\vec{E} \times \vec{B}$ ELECTRON ENERGY ANALYZER. MEASUREMENT OF DISTRIBUTION FUNCTIONS. Launspach, Jacques (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 73p. (In French). Dep. CFSTI (U. S. Sales Only).

An $\vec{E} \times \vec{B}$ electron energy analyzer which can be used in a weak magnetic field is presented. The focusing properties of the charged particles in crossed fields are used to obtain a large energy working range (.1 to 60 keV). The energy resolution is computed for different values of the parameters of the analyzer. As an example, the electron distribution function of the flux scattered through the mirrors of a magnetic bottle is measured and compared to the theoretical model obtained from the Boltzmann equation in which the electron-neutral collision term is dominant. (France)

24024 (FOA-4-4392) FUSION REACTION RATES AS DEPENDING ON THE PARTICLE DISTRIBUTION FUNCTIONS. Gustafsson, H. I. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jul 1969. 25p. Dep. CFSTI (U. S. Sales Only).

A few test functions assumed to represent steady-state isotropic particle distributions in the particle energy variable of the laboratory frame are constructed, discussed, and used for the averaging involved in the determination of reaction rates. The susceptibility of the rates to the forms of the distributions is examined. A numerical application is made for the D-T fusion reaction. The rates are compared to the Maxwellian rate, and discrepancies that may be experimentally significant are noted. (Sweden)

24025 (LA-4250) PROCEEDINGS OF SYMPOSIUM ON ENGINEERING PROBLEMS OF FUSION RESEARCH HELD AT THE LOS ALAMOS SCIENTIFIC LABORATORY OF THE UNIVERSITY OF CALIFORNIA, LOS ALAMOS, NEW MEXICO, APRIL 8-11, 1969. (Los Alamos Scientific Lab., N. Mex.). Jan 1970. Contract W-7405-eng-36. 354p. (CONF-690407). Dep. CFSTI.

Separate abstracts were prepared for 50 of the 68 papers. For abstract citations of the remaining 18 papers see Conf-690407 in the report number index. (M.O.W.)

For abstracts of individual papers see: 24026-24075.

24026 (LA-4250, pp A1,1-6) HOOP LEVATOR DESIGN FOR A PLASMA OCTUPOLE. Lien, Neil C.; Sviatoslavsky, Igor N. (Wisconsin Univ., Stoughton. Physical Sciences Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Plasma confinement time in a multipole device is limited to a large extent by the supports which hold up the hoops during an experiment. For this reason, the new University of Wisconsin Octupole is designed with removable supports which leave the hoops suspended freely in a magnetic field when the device is electrically pulsed. The levator mechanism is designed to operate in a 10^{-6} torr vacuum and support a 335 pound load on the end of a ball-socketed probe which follows a path such that the ball moves in a vertical straight line. The available room to mount and operate is small to obtain the stroke lengths of $4\frac{1}{2}$ in. and $6\frac{1}{4}$ in. which are required. High strength and light weight materials are used to minimize inertia effects. A bellows seal at the pivot point of the mechanism eliminates the need for sliding seals. The actuator is an electrically pulsed, pneumatic device designed to withdraw the probe support in 20 milliseconds, hold it withdrawn for 20 milliseconds, then partially reinsert it in 20 milliseconds to catch the hoop and absorb its energy of fall, and then return it to its original position. The actuator is pulsed by a three-way pilot-operated solenoid valve connecting it alternately to a high pressure and a low pressure pneumatic source. An intermediate pressure is used to give the initial thrust for removing the probe. Check valves and volume chambers are used to provide damping cushions and the means for probe location at the instant when the hoop is caught. Forces are directly transmitted through a ball-socketed connecting link from the levator to the actuator and through rigidly mounted body and end caps to the vacuum tank. An adjustable dummy piston rod guide determines the stroke and hoop elevation. Test results indicate the desired requirements are met. (auth)

24027 (LA-4250, pp A2,1-4) MAGNETIC PROPERTIES OF THE ORNL LEVITATED TOROIDAL QUADRUPOLE. Roberts,

M.; Alexeff, I.; Stirling, W. L.; Halchin, W. (Oak Ridge National Lab., Tenn.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Electromagnetic levitation of internal conducting hoops in a toroidal quadrupole has been achieved, producing a magnetic field for plasma confinement experiments. High magnetic field strengths are now available in this low-inductance quadrupole and a possible technique for producing time-invariant magnetic fields in the device is presented. (auth)

24028 (LA–4250, pp A3,1-6) MECHANICAL DESIGN OF A QUADRUPOLE INJECTION EXPERIMENT. Kewish, R. W. Jr.; Dike, R. S.; Hammel, J. E.; Sherwood, A. R. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A plasma gun is frequently used as a source of plasma for containment experiments in controlled fusion. In these experiments usually guns with low plasma energy output have been used. An injection experiment using the much more energetic plasma from a coaxial gun was designed. The coaxial gun plasma with its highly directed energy will be injected into a quadrupole geometry capable of stopping the 2.5-keV stream. The limitations placed on the design by the experimental requirements are: (1) an injection field of at least 6.5 kG but less than 10 kG (for self-depolarization of the plasma stream); (2) an MHD stable configuration which has at least 10 gyro radii across the stable region for 2.5-keV protons; (3) a maximum of 0.8 MJ in the magnetic field (because of availability); (4) coils suspended at one point by a dipole guarded current feed. With 2.5-keV ions it is mandatory that the support and feed be guarded because bombardment of any obstruction would hopelessly contaminate the system; (5) a maximum field of 40 kG; and (6) maximum current of 600 kA (because of current joints which lead to the necessity of designing a two-turn coil). The quadrupole coils, liners, and flux-smoothing shrouds were designed with the aid of a computer code developed by Baker and Mann. The guarded feed is a force-free configuration with its null line closed by a cross-feed at the coil surface. The design of this complicated region was guided by an examination of the analytic expression of the dipole field supplemented by probe measurements of a model of the feed region. This paper will discuss the results of the model analysis and the mechanical design of the experiment with the imposed constraints. (auth)

24029 (LA–4250, pp A4,1-4) PRINCETON SPHERATOR. Bonanos, P.; Christensen, U. R.; Mullaney, D. H. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The engineering aspects of the Princeton spherator are presented. The magnetic and mechanical design of the coils, structure, and vacuum system are described. Recent modifications including the installation of a superconducting poloidal field coil suspended within the vacuum tank are also related. (auth)

24030 (LA–4250, pp A6,1-5) PRINCETON FLOATING MULTIPOLE MACHINE. File, J. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The Plasma Physics Laboratory has undertaken the fabrication of a major toroidal quadrupole machine (FM-1) that utilizes levitated superconducting rings. The device has the flexibility to be used as either a spherator or a quadrupole. The detailed design of the FM-1 represents the major effort of the Engineering and Development Division of the laboratory during the past year. The vacuum vessel, external coils, superconducting rings, cryogenic equipment, stabilizing servo system, and associated equipment are described. The design of some of the major components is presented, and the progress to date of the effort is summarized. (auth)

24031 (LA–4250, pp B1,1-5) THE PROBLEM OF CONTROL OF THERMONUCLEAR REACTORS. Mills, R. G. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Of the various types of hypothetical thermonuclear reactor that have been considered as candidates for the eventual generation of commercial electric power, none has yet been proven to be physically possible. If a number of them proves to be possible, the most economical type will be adopted for practical applications. It appears at the present time that the least expensive would probably result if a machine could be fabricated in which a steady-state nuclear fire burns continuously with cold fuel injection. If such a machine is not possible, and the injection of energetic particles is necessary, the cost of such injection equipment would tend to raise the investment cost of a fusion power plant. Assuming a cold fuel injection machine, one in which the fuel is heated to the operating temperature by the plasma itself, it can be stabilized by feedback control of the plasma confinement time as well as other operating parameters. It is interesting to note that Bohm-type diffusion (in the sense that the diffusion rate varies with the plasma temperature) results in stable operation. It should also be noted that the operation of such a system requires a particular value of the product of the ion density and the plasma confinement time of the system. This $n_i\tau$ criterion also implies a certain fuel percentage burnup per pass through the machine. (auth)

24032 (LA–4250, pp B3,1-7) THE DATA ACQUISITION SYSTEM FOR THE SCYLLAC DEVICE. Gribble, R. F.; Brown, D.; Lillberg, J. W.; Sawyer, G. A.; Weldon, D. M. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

An automatic data acquisition and processing system utilizing a small digital computer is being constructed for use with the Scyllac toroidal theta pinch. "Scan converters" (storage oscilloscopes) will be the principal means of recording data. In a scan converter tube the signal is stored on a zinc sulfide screen in the form of low mobility electron holes written on the screen with a conventional oscilloscope gun. Reading of the data is accomplished by scanning the opposite side of the screen with a 1-kV electron beam and recording the position of those points where a change in secondary electrons from the screen indicates the presence of holes. The screen is scanned in a noninterlaced raster format with the read-beam position controlled by digital-to-analog circuitry so that the position of the beam is available in digital form when the stored trace is found. Accuracy of 0.2% (512 steps) is expected in reading either the vertical or time axis. On the write side of the tube, the sweep speed is variable from 1-μsec to 5-msec full scale, and the vertical rise time is adjustable to a 5-nsec minimum. Output from the scan converters is fed to an on-line digital computer for processing. Permanent storage on magnetic tape and temporary storage on a 0.37 million word (16 bit) magnetic disc will be available. Data from any scan converter can be brought into core from the disc on command, processed as desired, and sent to a CRT display system for inspection. This display system is fully buffered by a second magnetic disc which stores the data in the form of a television signal. The display scopes are ordinary television monitors driven by read heads scanning different tracks of the display storage disc. The computer will also monitor performance of Scyllac power supplies and spark-gap switches. (auth)

24033 (LA–4250, pp B4,1-4) DATA ACQUISITION FOR THOMPSON SCATTERING EXPERIMENT ON CHALICE. Carr, Wayne E. (Stevens Inst. of Tech., Hoboken, N. J.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

In a fast-rise, single shot experiment such as Chalice, there are several difficulties that must be overcome in data acquisition. The rapidly rising magnetic fields induce large emfs that must be discriminated against. In addition, the maximum possible amount of information must be obtained from each shot. Presented here is a system for collecting data from a Thomson scattering experiment. This system measures the frequency width of the scattered light from a 2-joule pulsed ruby laser by means of an 8-channel polychrometer. The detection device consists of a Spex ¾ meter monochrometer spectrometer, 8 plastic light guides connected to photomultipliers, followed by fast self-contained preamplifiers driving coaxial cables. These outputs are passively delayed and combined in such a way that the information is displayed on one oscilloscope. (auth)

24034 (LA–4250, pp B5,1-5) THE IMP FACILITY AT OAK RIDGE NATIONAL LABORATORY. Colchin, R. J.; Dunlap, J. L.; Edwards, R. S.; Hammond, D. P.; Massengill, L. A.; Rayburn, T. F.; Reinhardt, R. G.; Wells, E. R. (Oak Ridge National Lab., Tenn.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

IMP (Injection into a Microwave Plasma) is a fusion device for investigation of hot ion accumulation by injection of an energetic H^0 beam and trapping by resonant charge exchange on a target plasma established by high-frequency (35 GHz and/or 55 GHz) microwave heating. Principal components are a neutral injector, a superconducting coil system within a 200 cu. ft. vacuum chamber, and a beam dump. After a brief description of these principal components, we will review the design criteria and discuss more fully mechanical assembly and the vacuum pumping system. De-

tails specifically related to the magnet system (field contours, winding layouts, winding techniques, and choice of superconductor) will be covered in other papers. (auth)

24035 (LA--4250, pp B7.1-6) TECHNOLOGICAL PROBLEMS ASSOCIATED WITH THE ADDITION OF A HARD CORE TO THE PHAROS 2 MJ θ-PINCH. Young, Marvin P. (Naval Research Lab., Washington, D. C.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

An axial current conductor (hard core) was added to the Pharos θ-pinch facility for a series of stability experiments. The axial conductor is made from thick-walled aluminum tubing (1.27-cm outside diameter and 0.16-cm wall thickness). It is wrapped with Mylar and polyethylene and further insulated from the plasma by a quartz tube (2.1-cm outside diameter and 0.3-cm wall thickness) which forms the inner wall of the plasma-containment vessel. An adjustable-tension wire structure inside the 335-cm-long conductor eliminates its sag, and an overall axial alignment of less than ±1 mm is maintained. A 700-kJ, 100-kV capacitor bank supplies the energy for the hard-core circuit. The bank, assembled from 20-kV capacitors and switches, operates as a five-stage Marx-type circuit to generate the required 100-kV energy source. An oil-filled coaxial 100-kV current collector terminates the 28 coaxial cables from the parallel capacitor bank sections and mechanically supports the axial conductor. A molded polyurethane housing with an inflatable chamber to affect a constricting O-ring surface provides a vacuum seal for the ends of the plasma-containment tubes. This technique allows quick assembly and eliminates the heretofore required close tolerances of eccentricity and outside diameter of the large quartz tubes. (auth)

24036 (LA--4250, pp B8.1-5) SOME REMARKS ON THE ENGINEERING PROBLEMS ENCOUNTERED IN THE CHALICE EXPERIMENT. Yevick, G. J.; Harvey, R.; Carr, W.; Karol, J. (Stevens Inst. of Tech., Hoboken, N. J.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The Chalice experiment involves the production of hot dense plasma by means of two θ pinches. The plasma is then injected into a cusp field for long-time confinement. A description of the new electrical tie-up is presented along with a novel self-crowbarring, metallic contact, solid dielectric series switch. A modular coil-switch system, now operating at 20 kV and 1.5 megamps, has been designed and tested. Diagnostic measurements have included density measurements, with a Mach–Zender, and temperature measurements making use of the C_V line. In order to increase the sensitivity of the density measurement a Michelson interferometer has been built and tested. For temperature measurements, Thomson scattering will be performed. Serious thought has gone into finding an inexpensive, powerful, easy-to-handle method for measuring the space-velocity distribution function $f_s(\vec{x},\vec{v},t)$ for both ions and electrons. At the present time, the density $\rho(\vec{x},t) = \int f(\vec{x},v,t)\, d\, v$ is measured somewhat crudely with a Mach–Zehnder. Thomson scattering does provide information on the velocity distribution and in principle could yield $f(\vec{x},\vec{v},t)$. The possibility of using two different frequencies and picking up the beat is now being investigated and preliminary theoretical analysis indicates considerable promise in this direction. (auth)

24037 (LA--4250, pp CI.1.1-6) CAPACITOR DEVELOPMENT FOR SCYLLAC. Boicourt, Grenfell P. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The capacitor requirements for Scyllac are described. The history of the development of the 1.85-μF, 60-kV primary bank capacitor is covered in detail. During the development of this unit, it was found that many areas were not being properly controlled during manufacture. As a result it is felt that the successful development of the 1.85-μF capacitor has resulted in a significant upgrading of general manufacturing practices. The life characteristics and electrical products of the 1.85-μF, 60-kV unit are given. Some attention is given to the developmental problem of high density B_0 capacitors, the preionization capacitor, and high-Q stabilization capacitor. (auth)

24038 (LA--4250, pp CI.2.1-5) THE DEVELOPMENT OF RELIABLE, HIGH-VOLTAGE, LOW-INDUCTANCE CABLE FOR SCYLLAC. Boicourt, G. P.; Kemp, E. L. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Scyllac requires over 750,000 feet of low-inductance coax cable. There will be over 25,000 individual cables operating simultaneously and any cable failure will stop operation of the entire system. A cable development program involving several companies in the cable industry was begun in 1966 to develop a reliable cable to operate as load cable in a capacitor bank charged to 60 kV and switched with pressurized gaps. The cable has a foamed polyethylene core and uses the braid of RG 14/U cable as the center conductor. The main insulation is extruded over the inner braid and the outer conductor is braided over the insulation. A final jacket is applied to make a cable that approximates the size of RG 17/U. The inductance of cable made in this manner is less than 40 nH per foot but this cable will not operate reliably at 60 kV. It was found during the development program that the voltage reliability could be improved by extruding conducting dielectric screens adjacent to each side of the main insulation. Reliable cable with an inductance of about 45 nH per foot is now commercially available. This paper describes the tests used for evaluation and details some of the problems encountered in this development. (auth)

24039 (LA--4250, pp CI.3.1-8) THE DESIGN AND DEVELOPMENT OF CABLE CARTRIDGES FOR SCYLLAC. Hanks, K. W.; Boicourt, G. P. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

One of the critical components in the Scyllac system is the cable cartridge. The primary function of the cable cartridge is to terminate coaxial cables into a parallel plate transmission line. Each cartridge has been designed for minimum inductance and must hold off the 60-kV primary voltage plus any superimposed transient voltages which may occur in the system. These short duration peak voltages may reach as high as 143 kV. In addition, the cartridge geometry must efficiently transfer 120,000 amps. The magnetic forces which are generated between the collector plates are retained by a through-bolt which is incorporated into the design of each cartridge. Both mechanical and electrical problems have developed with respect to materials used for the basic components of the cartridge. These problems and solutions will be discussed. The final design of the linear Scyllac system requires four different types of cartridges. One hundred-twenty-three total cartridges are required for each meter of machine, of which there are 59 top-fed and 64 bottom-fed cartridges. Each meter of machine uses only two types of cartridges. Each adjacent meter uses a set of reversed polarity cartridges. Each type of cartridge has been initially certified in a 75-kV test system for a minimum of 5000 shots with voltages being applied that are characteristic of the Scyllac system. Each set of top- and bottom-fed cartridges will have their final certification when they are installed in the Scyllac prototype machine. The history of the development of these cable cartridges and methods of testing and evaluation will be presented. (auth)

24040 (LA--4250, pp CI.4.1-5) AN INERT-FLUID COOLED AND MAGNETICALLY SHIELDED LOW-POWER KLYSTRON MILLIMETER SOURCE. Ernst, W. P. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The cooling effectiveness of completely immersing a low power, millimeter reflex klystron in an inert fluorochemical liquid bath is reported. A closed cooling system, not requiring liquid circulation, is provided by the boiling–vaporization–condensation cycle of the cooling process. The operating temperature of the klystron tube is controlled by the boiling temperature of the fluorochemical. Klystron warmup time and long time frequency stability, using the inert fluid cooling are compared to that provided by forced air. Since the inert fluid cooling is a closed system, more effective mag-shielding may be used. With the klystron millimeter source applied to a microwave spectrum analyzer, operating performance is compared using two types of cooling: (a) forced air with klystron tube inside a long cylindrical magnetic shield and (b) inert fluid cooling with magnetic tape completely lining the fluid reservoir. (auth)

24041 (LA--4250, pp CII.1.1-4) DIGITAL CONTROL OF A RESEARCH DEVICE. Simon, E. D.; Duritt, S. P.; Pelovitz, M. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Operation of the FM-1 research device at the Plasma Physics Laboratory will require an entirely new control complex. This system will provide the functions of startup, shutdown, enable–disable, arm–disarm and start–stop. In providing these functions the control system must be designed in such a way that failure will not cause a hazard to personnel or equipment. Experience with the existing control systems at PPL indicated the following shortcomings in relay systems. First, they are very inflexible. They do not provide detailed status information. Relay systems are also very costly. By comparison digital process control is very flexible and can give extensive status information but the initial cost is high. The FM-1 operator will use lighted push buttons in

the console. Conditions which prevent the normal sequence of operation will be displayed on a storage scope. Field levels and timer settings can be set by a 10-button "touch tone" input. The normal operations log will be printed on the typewriter. Parameter settings will be punched on cards. (auth)

24042 (LA-4250, pp CII.2.1-5) PROGRAMMING LOGIC USING AN IBM 1800 PROCESSOR CONTROLLER. Pelovitz, M.; Duritt, S. P.; Simon, E. D. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The IBM 1800 Processor Controller responds to input signals from push buttons or monitoring devices through several logic systems. These include a priority interrupt level scheme, a continuous scan of all digital input strips, and calls from a queuing table where programs are stored with a given priority to await execution. Outputs are handled by programming the controller to update all output terminal strips every 80 milliseconds. During this time interval any desired output changes are made by programming these changes into the contents of the machine addresses where the output information is stored. Differences in design concept for an existing relay system and this programmed system are described. Some of the problems which might be encountered in the programming are pointed out, as well as the steps necessary for establishing a program using the controller's full capabilities. (auth)

24043 (LA-4250, pp CII.3.1-6) DESIGN AND TESTING OF SERVO STABILIZING SYSTEMS FOR LEVITATED SUPERCONDUCTING RINGS. Thompson, P. A.; Sheffield, G. V.; Tenney, F. H. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The general problem of providing stability for one or two levitated, current-carrying rings is presented, and the desirability of using an active system of correcting coils, servoed to ring displacements, is discussed. Computer codes for calculating systems parameters for a linearized analysis and for simulating complete ring dynamics for an actual system design are described. A comparison of the computer studies to results obtained with the magnetic model test stand for the FM-1 machine is given, along with technological developments associated with these results which have special implications to the computer work. (auth)

24044 (LA-4250, pp CII.5.1-4) COMPUTER-CONTROLLED ELECTRONIC SEQUENCE TIMER. Schweitzer, S. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

An electronic sequence timer which may be controlled either by a set of thumbwheel switches or by an IBM Model 1800 Process Controller is described. Unusual features of the logic employed, and of the output circuitry, are described in detail. (auth)

24045 (LA-4250, pp CII.6.1-5) DIAGNOSTIC DRIVES AND CONTROLS. Foote, V. S. Jr. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Present day plasma research devices, with their multiplicity of diagnostics in combination with limited operator access, can pose many problems in the acquisition of the required data. The evolution over a number of years of the drive and remote control systems for diagnostic positioning devices now in use at PPL is described with examples. Drives used with positioning devices for both "in-plasma" and "external" diagnostics are discussed, as well as questions of reliability, safety, convenience, cost, and standardization. Present trends in design such as automatic logging and programmed control of probe positioning mechanisms are discussed, and a new type of incremental drive motor (utilizing stray magnetic fields between solenoid coils) presently under test is introduced. (auth)

24046 (LA-4250, pp CII.7.1-4) PROBE POSITIONING MECHANISMS. Christie, R. S. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

For many years instrumentation of plasmas has made use of movable probes usually provided with a linear motion only. From these single degree of motion positioning mechanisms a PPL "standard design" has evolved after three major developmental modifications. Minor alterations in the design of this probe mechanism and variations in the method of mounting it, have increased its flexibility and usefulness to the extent that it is able to position a probe anywhere in a specified volume. The standard device, special mechanisms designed to solve particular positioning and measurement problems and probes of an unusual and miniature nature are described and illustrated. The probe tip motions obtained by the mechanisms are shown through use of multiple exposure photography. (auth)

24047 (LA-4250, pp DI.1.1-3) INDUCTIVE CIRCUIT SWITCHING. Murray, J. G.; Bronner, G. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Two experiments of inductive energy switching are described. (1) A direct-current interrupter utilizes a relatively small external power supply to drive the breaker current to zero. (2) Inverters in inductive storage systems can be used to limit the voltage on interruption and to facilitate efficient energy transfer. (auth)

24048 (LA-4250, pp DI.2.1-5) STANDARD COMMERCIAL IGNITRONS AS HIGH VOLTAGE SWITCHES. Turitzin, Nicholas M. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Test results performed on ignitrons types 5550 and NL-1053 used as high-voltage switches are given. Static voltage breakdown, dynamic voltage breakdown, internal dark and bright tube resistance, tube voltage drop, arc transfer, ignitor resistance and factors influencing the tube life have been investigated. A high-voltage ignitron switch using series connected ignitrons is described. (auth)

24049 (LA-4250, pp DI.3.1-4) 100 kV PRESSURIZED TRIGATRON SWITCH. Burton, J. K.; Glock, W. R.; Lupton, W. H. (Naval Research Lab., Washington, D. C.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A pair of low-cost trigatron switches were developed for use at 100 kV. The switches exhibit a delay of less than 10 nsec and a jitter less than 5 nsec. One of the switches was initially designed for low-current use with medium inductance for a 10^6 volt LC generator. The second switch was designed for a system requiring a low-inductance switch with high current capability (140 kA). No degradation appears in the operating characteristics of the high-current switch after 200 operations. (auth)

24050 (LA-4250, pp DI.4.1-5) SCYLLAC SPARK GAP AND TRIGGER SYSTEM DEVELOPMENT. Hammer, C. F.; Gribble, R. F. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The Scyllac primary energy system consists of three-thousand two-hundred forty 1.85-μF, 60-kV capacitors with a 4-element spark gap mounted on each capacitor. When triggered the spark gap transfers the stored energy from the capacitor to the load coil. The Scyllac trigger system must trigger all 3240 spark gaps and with a jitter (or simultaneity) of 10 nsec rms. Each 4-element spark gap is required to hold off the 60-kV bank voltage until triggered, then carry a peak current of about 60 kA. The spark gap consists of 3 main electrodes and an illuminating spark plug. The gap spacings are $\frac{1}{4}$" and $\frac{1}{2}$". It is pressurized to 20 psig which raises the voltage holdoff capability to 120 kV. The gap is operated with the capacitor charged negative, and the center electrode biased to $\frac{1}{3}$ the capacitor voltage. A $1\frac{3}{4}$" wide brass ring is attached to the center electrode to provide additional capacitance to the fast-rising trigger pulse. A major consideration in the design of this gap was to be able to operate the gap in a fast swinging cascade mode. The Scyllac trigger system uses charged coaxial cable as the energy source for the fast trigger pulse. The system has been designed so that each trigger gap will trigger fifty-four 4-element spark gaps. Therefore, the Scyllac trigger system consists of 60 submaster trigger gaps and one master trigger to trigger all the submaster gaps. The coaxial source cables are charged to 100 kV with a pulse which has a risetime of 12 μsec. The trigger system delivers an 80-kV pulse with a risetime of 100 nsec, when measured with a coaxial 50-Ω resistive load. The trigger gap is also a 4-element spark gap with electrode spacings of $\frac{1}{16}$" and $\frac{1}{8}$" and is pressurized to 45 psig. Low inductance was an important design criterion for this gap. A detailed description of the 4-element spark gap, trigger gap, and trigger system will be included. (auth)

24051 (LA-4250, pp DI.5.1-3) FERRITE LOADED PIGGYBACK CROWBAR GAP. Gribble, R. F. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

To provide a reliable, low-maintenance, passive crowbar for Scyllac a pressurized, ferrite-loaded spark gap was developed to connect directly to the load start gap on each primary bank capacitor. Use of ferrite for trigger decoupling is similar to that

of Isar I at the Institute for Plasma Physics, Garching, West Germany. The ferrite introduces a saturating inductance between the trigger electrode and ground or load return. Trigger current from a 75-kV capacitor passes through the coaxial housing containing ferrite toroids and across a spark plug in the trigger electrode. Polarity is such that the crowbar switch does not break down when the crowbar trigger is switched one-half trigger current period before load current peak. During the first half cycle the trigger current at the spark plug drives an ionizing fountain into the inter-electrode region. At the end of the first half cycle of the trigger and at the load current peak the crowbar gap is closed by the pulse on the trigger electrode as the trigger current passes through zero, switching saturation states of the ferrite. For an experimental arrangement consisting of two parallel 2-μF, 50-kV capacitors and gaps having a quarter-cycle load current risetime of 4 μsec and a crowbar trigger current of 10-kA peak at 500 kHz, the crowbarred load current modulation was 6%, and the e-folding decay time was 310 μsec. (auth)

24052 (LA-4250, pp DI.6.1-10) SOLID DIELECTRIC CROWBAR SWITCH. Call, Darrell L. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Development work on the Marshall-type solid dielectric switch for Scyllac and other machines is reported. Scyllac will have a peak current of 10 MA per meter section which requires a minimum total switch length of about 12 inches per section to carry the current with a reasonable margin of excess capability. The switch was originally developed as a 2.5-inch switch so that four or five switches per section of Scyllac would be required, which is a formidable operating problem. Assemblies which would close 6 inches of switch were tested in a machine where the switch operated as a start switch. Foil shape, foil exploding capacitor bank, compressive pressure on the switch assembly, foil encapsulation laminating process, and switch insulation thickness were parameters varied during testing. The extruding portion of the switch (switch plate) was changed to a slotted, flattened tube for convenience and to direct the current in a path which uses magnetic pressure to keep the switch closed after closure. Maximum current-carrying capability of this type switch was determined with a one-inch-long exploding foil and found to be just above 1 MA per inch of switch length. This one-inch switch is suitable for many modest crowbarring problems where up to 60 kV must be held off and up to 1 MA is to be crowbarred. Switch closure time jitter with the 2.5-inch switch is 0.01 μsec. As switch length was increased to 4, 5, and 6 inches, the jitter increased to the order of 1 μsec. Jitter and closure time are affected by almost all physical parameters of the switch. Closure time is strongly dependent on impedance matching between the exploding foil energy source and the exploding foil itself. Optimization of this matching was studied. The possibility of driving the exploding foil with an inductive energy source is suggested. Some initial studies and tests using high explosives instead of an exploding foil are reported. Study of the crowbar problem on the NET-1 circuit analysis program is reported where the solid dielectric switch acts to relieve a piggyback spark gap or ignitron crowbar switch and where it is the only crowbar switch in the system. (auth)

24053 (LA-4250, pp DI.8.1-6) USE OF EXPLOSIVE GENERATORS TO POWER THE θ-PINCH. Damerow, R. A.; Crawford, J. C. (Sandia Corp., Albuquerque, N. Mex.); Thomson, D. B.; Caird, R. S.; Ewing, K. J.; Garn, W. B.; Fowler, C. M. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Explosive-driven generators have been used to create neutron producing plasma in conventional θ-pinch coils. The generators were spiral wound flux compression devices which were loaded with 5 lbs, or 17 lbs, of high explosive depending on the model. When used with an exploding wire switch, the generators have produced θ currents of approximately 2.5 MA or 5 MA, respectively. The smaller generator has provided switched currents into 25-cm-long θ coils with rise times of 1.6 to 2.7 μsec, corresponding to peak fields of 106 to 128 kG. The highest neutron yield from this system was about 7×10^5. For the larger generator, peak currents ranging from 4.2 to 5.1 MA were switched into θ coils of lengths 25 and 35 cm. Peak magnetic fields obtained varied from 141 to 220 kG with rise times ranging from 2.1 to 4.0 μsec. Coil voltages around the θ coils at time of switching ranged from 37 to 70 kV. Neutron yields as high as 1.4×10^8 were produced. These results indicate that the larger generator, on a one shot basis, compares favorably with present high energy fast condenser banks for θ-pinch production. Engineering problems which relate to matching the generator to the θ pinch, such as the importance of the operation of the high voltage switch, and the features unique to the single shot nature of the experiments, are discussed. Comments are made on some plasma conditions that might be reached if substantially larger generators are used. (auth)

24054 (LA-4250, pp DI.9.1-4) HIGH ALTITUDE PULSED PLASMA POWER SUPPLY. Fowler, C. M.; Thomson, D. B.; Ewing, K. J.; Caird, R. S.; Garn, W. B. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A pulsed power supply under construction is described which can be used in space physics experiments. The supply considered here is designed to drive a coaxial plasma gun. Rocket and plasma gun requirements which the supply should meet include the following. The payload vehicle is approximately 11 ft long, has a maximum diameter of about 2½ ft and allows about 500 lbs for the power supply. In the early flight stages, accelerations of 10 to 15 g's are encountered. A stabilizing spin of 3.5 rps is required, which subjects peripheral components to accelerations greater than 20 g's. The plasma gun will require pulsed energy of 2 to 400,000 joules, switched in at a voltage of between 5 to 10 kV across the gun breech, and a subsequent operation time of several tens of microseconds. The basic power plant consists of two explosive-magnetic generators operating in sequence. The first generator amplifies the energy obtained from a small capacitor bank (78,000 joules, 250 lbs weight) sufficiently to supply the output generator. It, in turn, after further amplification delivers energy to the plasma gun. A dielectric switch is designed to switch the plasma gun into the circuit at a time when 5 to 10 kV will be placed across the gun breech. The present status of the power package will be reviewed including current results and environmental testing procedures carried out on various components. Explosive generators may make accessible space physics experiments which would normally be prohibitive from the standpoint of payload weight limitations. (auth)

24055 (LA-4250, pp DII.1.1-7) MOLECULAR FLOW AND SURFACE ABSORPTION IN GENERAL AXIALLY SYMMETRIC GEOMETRIES BY THE MONTE CARLO METHOD OF CALCULATION. Wakefield, K. E. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The vacuum chamber of the Princeton Floating Multipole contains a divertor situated such that the ionized particles approaching the walls of the main reaction chamber are guided by the magnetic field lines to a baffle deep within the divertor structure; neutral particles, which originate at the point of impact, are prevented from easily returning to the main plasma by a labyrinth of vanes and other structural members. The backflow of neutral particles can be substantially reduced by coating the vanes with a gettering material, especially if the design is such that the average particle makes many collisions with walls so coated before finding its way back to the main reaction chamber. Since the gettering material saturates when a monolayer of gas has been absorbed, this improvement is practical only when the plasma is formed on an intermittent basis, with reapplication of the getter after each pulse. A Monte Carlo computer program for evaluating such a system is described, taking into account the intricacies of the geometry and the absorption properties of those elements containing the getter, including possible local saturation effects. The program can simulate any axially symmetric configuration containing combinations of absorbing surfaces having a specified sticking probability and saturation density, nonabsorbing surfaces, and escape or entrance ports. Results are valid only for gas densities such that the frequency of intermolecular collisions is small compared to the frequency of collisions with the wall. Application of the program to the divertor described above is illustrated. The program has also been used to determine the emission of neutral particles from a Marshall-type gun as a function of time, and to optimize the conductance of an optically opaque section of vacuum line. (auth)

24056 (LA-4250, pp DII.3.1-3) A SIMPLE, INEXPENSIVE TITANIUM SUBLIMATOR. Culver, J. S. (Oak Ridge National Lab., Tenn.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The titanium sublimator developed to pump the large gas loads in the DCX-2 machine provides a simple, rugged, inexpensive device that gives high evaporation rates and is made of commercially available materials. These filament-type sublimators are run both parallel to and normal to the 12-kG field in the machine. The filaments consist of a ten-inch length of tantalum or molybdenum wire surrounded by an 8-inch length of ¼ in. × 0.065 in. wall tubing of grade II titanium. When operated at a current of 250 to 300 amperes, evaporation rates of 0.1 to 1.0 grams per hour

are obtained. The total amount of titanium evaporated is about 10 grams per filament. (auth)

24057 (LA–4250, pp DII.6.1-3) Q-MACHINE HOT PLATE DEVELOPMENT. Wittman, F. E.; Henderson, Dale B.; Dreicer, Harry (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A hot plate was designed to contact ionize an atomic beam of cesium. After testing materials and various configurations, a multiple-disk construction, held in compression with draw bolts and insulated with ceramic, was used. The hot plate consists of three stages: a conical filament, to minimize $J \times B$ forces due to the presence of an externally applied magnetic field; a cathode, heated by electron bombardment from the filament; and an anode or hot plate, three inches in diameter and $\frac{1}{4}$ inch thick. The grid is a ring spaced around the outside of the cathode. When the potential on the grid is made more positive than the space charge limited cathode, an increase in electron current, in the form of a coaxial ring, strikes the anode. This ring of electrons compensates for the heat losses due to the anode support. By adjusting the coaxial ring and cathode to anode current, the radial temperature profiles can be made to have positive, negative or nearly zero temperature gradients. Tungsten is used for the hot plate, cathode, filament and cathode support rod. Tantalum is used for the filament supporting disks, grid, hot plate cap and heat shields. Molybdenum is used for the draw rods. Copper is used for the support chamber, baffles and water cooling. Al_2O_3 ceramic and boron nitride are used for voltage and thermal insulation. Filament lifetimes average 100 hours for a tungsten foil one mil thick and a current of 0.12 ampere per mil width. The filament requires 3700 watts at 6.7 volts, the cathode uses 4000 watts at 2,300 volts, and the combined power required varies between 10,000 and 12,000 watts depending on the grid potential. Temperature measurements, made on the hot plate in the isothermal case using an optical pyrometer, indicate a temperature of 2200°K with a total variation of 5°K across the surface. (auth)

24058 (LA–4250, pp DII.7.1-4) A TWO-TERMINAL MARGINAL OSCILLATOR EASES NMR PROBE-CABLE RESTRICTION. Weissenburger, A. W. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A marginal oscillator is described which satisfies a need for use in simple economical NMR systems that measure magnetic field intensity. Advantages of the basic oscillator circuit, which uses dual feedback in conjunction with a series-tuned probe, are discussed. The choice of frequency modulating the oscillator rather than employing conventional B field modulation permits the use of a simpler probe structure. A circuit diagram is given. (auth)

24059 (LA–4250, pp DII.9.1-6) LIQUID RESISTOR DEVELOPMENT. Haarman, Roy A. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Recent efforts at Los Alamos to develop a liquid resistor are described. In certain circuits containing paralleled groups of high-voltage energy-storage capacitors, a danger exists if a charged capacitor shorts or prefires. The energy from the adjacent groups, if large enough, will tend to discharge into the faulty capacitor and cause a violent rupture. This danger can be eliminated by either: (1) installation of a high voltage dc fuse to isolate the faulty capacitor, or (2) installation of a resistor that will dissipate the energy from the adjacent capacitors. In the Scyllac Project, circuit parameters require that the resistor be a 60-kV, 2000-ohm unit capable of dissipating 680×10^3 joules, with a discharge time constant of 0.8 seconds. Calculations and experiments indicate that a liquid resistor can meet the requirement and be undamaged by repeated discharges, eliminating replacement problems. Basically the liquid resistor consists of two metal electrodes separated by an aqueous salt solution. Brass electrodes with a $CuSO_4$ electrolyte and stainless steel electrodes with a K_2SO_4 electrolyte were tested. The liquid resistor dissipates the energy in the form of heat according to the relationship $Q = MC\Delta T$, where ΔT is the temperature rise of the electrolyte. Various tests were performed to verify the energy absorption characteristics, temperature coefficient effects, polarization tendencies and electrolysis measurement for electrode-electrolyte compatibility. The procedures, results and conclusions of these tests are presented. (auth)

24060 (LA–4250, pp DII.10.1-4) SKIN-EFFECT PULSE TRANSFORMERS. Harvey, Robin J. (Stevens Inst. of Tech., Hoboken, N. J.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Efficient coupling of magnetic flux between two coils may be accomplished without the need for an iron core if the coils are wound in the proper way from a strip of low-inductance transmission line. The band pass of such a transformer extends from the lower limit imposed by the finite skin depth of the conductors to the cutoff due to capacitive coupling (or the speed of light to coil circumference ratio). In the case of the power-pulser-high-voltage-isolation transformers which were built for use on the Chalice experiment the band pass is roughly 50 kc to 50 Mc. The design and construction of such "skin-effect" transformers are discussed with particular emphasis upon applications involving medium to high energy transfer (1 to 10^6 joules). (auth)

24061 (LA–4250, pp E2.1-5) PRECISE REGULATION OF A 500 kW D. C. GENERATOR WITH A 2500 AMPERE SERIES-PASS TRANSISTOR BANK. McLeod, John; Rand, John Langdon (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Design, construction, and testing of a transistor regulator and control system for ±0.01% regulation of a magnet power supply are described. By placing a fast electronic regulator in series with the generator the problems inherent in quickly changing the generator output by forcing current into the field winding are avoided. Generator field control is used to maintain the average potential drop across the transistor regulator at its optimum value of 7 volts. Two closed loops are used to control load voltage and current. Changes in load voltage or current will affect the drive to the series-pass transistor element. The voltage feedback is balanced against a voltage developed by integrating the difference between the measured current to the magnet and the reference. Thus, the current feedback loop with a response time of 50 milliseconds contains the voltage feedback loop with a response time of 1 millisecond as a nested element. The current loop response time of 50 milliseconds is adequate since its principal purpose is to correct for the effect of changes in magnet temperature. The voltage loop corrects for changes in generator output due to transients and armature asymmetry up to about 160 Hertz. Faster changes do not affect the magnetic field, and can be allowed to appear across the load. The load and transistor regulator are water cooled by a closed-loop water to air heat exchanger. Protective circuits are provided to prevent transistor burnout with alarm and automatic shutdown in case of various equipment failures. Field stability of ±0.5 gauss at 3.5 kilogauss has been achieved. Current stability of ±0.01% of operating point appears to be limited by stability of the reference source. (auth)

24062 (LA–4250, pp E3.1-7) VARIABLE-VOLTAGE, DIRECT-CURRENT POWER SUPPLIES FOR ENERGIZING CRYOGENICALLY COOLED AND SUPERCONDUCTIVE ELECTROMAGNETS. Laurence, J. C.; Meyn, E. H.; Jirberg, R. J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Power supplies for energizing electromagnets, cryogenically cooled and superconductive, and their control circuitry are described. The first is a dc generator of the homopolar type with a continuous rating of 0 to 60,000 amperes at 38 volts. Overloads of up to three times the continuous current output are available for a duty cycle of 2 minutes. Control circuitry provides for complete reversal of the output voltage by reversing the direction of exciter field. This feature is useful for discharging an electromagnet in the shortest possible time. The second of these converts three-phase, 440-V, 60-Hz power into a variable voltage (0 to 45 V), direct current (0 to 15,000 A) continuous rating with a 200% overload rating for a duty cycle of 2 minutes. The fundamental ripple frequency is 360 Hz and its peak-to-peak amplitude is less than 18% of the dc output voltage. Variations in the preset dc output voltage under continuous load are limited to ±1% when the ac input power variations are regulated to ±5%. (auth)

24063 (LA–4250, pp E4.1-5) HIGH POWER TECHNOLOGY ASSOCIATED WITH DENSE PLASMA FOCUS RESEARCH. Ware, K. D.; Carpenter, J. P.; Bottoms, P. J.; Williams, A. H.; Mather, J. W. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The technology of a fast, 120-kJ, 50-kV capacitor bank used with the dense plasma focus experiments (DPF-V), which has the capability of delivering ~5 MA into a shorted load, is discussed. The capacitor bank has twelve 10-kJ, 50-kV modules that fire simultaneously to within ±10 nsec. Each module consists of four, 2-μF, 50-kV capacitors parallel connected by a closed coaxial header to a single vacuum switch. The capacitor-switch module is triggered by a coaxial spark plug with a fast rising transformer isolated pulse, 1.3×10^{12} V/sec up to 60 kV, and has an output voltage rise rate of 1.5×10^{12} V/sec. The vacuum switch has dis-

charged the 10 kJ of energy while repeatedly passing currents of 0.4 MA over a thousand shots. (auth)

24064 (LA–4250, pp E5,1-2) IMPEDANCE MATCHING THE PLASMA FOCUS DEVICE. Carpenter, J. P.; Ware, K. D.; Bottoms, P. J.; Williams, A. H.; Mather, J. W. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The electrical circuit for a dense plasma focus discharge is analyzed and the important parameters for optimizing the current to the discharge are obtained. Electrical and geometrical means for increasing the available current to the discharge are investigated. Optimization of the magnetic energy in the system is discussed. (auth)

24065 (LA–4250, pp E6,1-6) INTERCHANGEABLE THETA-PINCH PLASMA FOCUS MACHINE. Wolfe, Charles P. (National Center for Atmospheric Research, Boulder, Colo.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A 224-uf, 17-kV capacitor bank capable of interchangeably driving either a single turn theta-pinch coil or a high density plasma focus gun was constructed at the High Altitude Observatory. This device is used as a spectroscopic light source for the study of atomic spectra of astrophysical interest in the soft x-ray and vacuum-ultraviolet regions of the spectrum. When deuterium is used in each of the configurations, no detectable neutrons are generated in the theta pinch, but a copious amount of neutrons are observed with the focus arrangement. Design criteria and operational characteristics of the machine will be described. (auth)

24066 (LA–4250, pp E7,1-6) APPLICATION OF THE NET-1 NETWORK ANALYSIS PROGRAM TO DISTRIBUTED CIRCUITS. Boicourt, Grenfell P. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The NET-1 Network Analysis program is an engineering-oriented computer program for calculating the voltages and currents in an electrical network as functions of time. This paper describes the program briefly and discusses the modeling procedures for capacitors, cables, inductors, and switches, as well as large scale capacitor discharge circuits. Several examples are given which illustrate the exceptional capabilities of the program. (auth)

24067 (LA–4250, pp E8,1-4) HIGH CURRENT COAXIAL DC BUS SYSTEMS. Bushnell, Charles W. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Water cooled coaxial dc bus systems, constructed of standard sizes of copper pipe and tube, with current ratings of 500, 5,000 and 20,000 amperes are discussed with regard to the design parameters pertinent in the immediate proximity of a magnetic device. The attractiveness of a coaxial system is quite obvious when (1) design for normal and fault loading due to self fields, (2) design for loads due to stray fields, and (3) generation of disturbing magnetic fields are considered. The test results from prototype designs are used to compare and evaluate the coaxial systems with the more standard water and air cooled bus. Parameters considered include: (1) space requirements, (2) power requirements, (3) total system costs, (4) material availability, and (5) design flexibility. (auth)

24068 (LA–4250, pp E9,1-8) HIGH-CURRENT JOINT TECHNIQUES. Dike, R. S.; Borkenhagen, W. H. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Various methods of transferring high-current pulses in the range of 5 to 100 kA/cm through mechanically-made joints of a type that can be easily disassembled are discussed. The examples cited and the techniques involved are taken from devices actually in successful operation. Several different joint designs have been developed and those presented are divided into the following categories: (1) joints for flat plates; (2) joints for round bars; and (3) joints for cable terminations. (auth)

24069 (LA–4250, pp F1,1-10) THE FINAL DESIGN OF SCYLLAC. Kemp, Edwin L. (Los Alamos Scientific Lab., N. Mex.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Scyllac is a theta-pinch machine 15-m long with a 10-cm coil diameter. Two versions will be built, a 10-meter linear model and a 5-meter curved sector and later, a 15-meter circumference toroidal model. The same capacitor bank and collector plates will be used for both versions. The machine will be divided into 15 coil, collector plate sections. The 720-kJ Primary bank for each section will consist of 216 capacitors, each capacitor having a spark gap and 6 low-inductance coaxial output cables. The cables from each pair of capacitors will terminate at the collector plate in a low-inductance cable cartridge termination. Each collector plate will also have a high frequency B_z preionization system and a reverse, B_θ system. The toroidal system will also include static and dynamic stabilization systems. The design of Scyllac is proceeding in three phases: component development, system development, and system design. The main components being developed are: a 1.85-μF, 60-kV capacitor; reliable, low-inductance coaxial cable; a low jitter, 60-kV "start" spark gap that also incorporates a "crowbar" spark gap; a low-inductance, cable cartridge termination; plug-in connectors, and miscellaneous hardware. After the components have been approved by the development laboratory they are installed in substantial quantities in a prototype system and tested. The components that qualify in the prototype system are used in the Scyllac system design. This paper describes the component developments, the prototype system testing program, and the final design of the complete Scyllac system. (auth)

24070 (LA–4250, pp G5,1-5) SUPERCONDUCTOR EVALUATION TESTS FOR IMP. Coffey, D. L.; Gauster, W. F. (Oak Ridge National Lab., Tenn.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Physically similar quadrupole magnet systems, using NbTi and Nb_3Sn, have been considered for IMP. State-of-the-art techniques for the two types of magnet systems are compared for volume requirements, conductor price, stability, current density, and mechanical rigidity. The results of an extensive material testing program are reviewed in an attempt to correlate short sample and coil performance, and to empirically define the conductor conditions leading to electrical stability. (auth)

24071 (LA–4250, pp G6,1-4) WINDING TECHNIQUES FOR SUPERCONDUCTING MAGNETS. Brown, R. L. (Oak Ridge National Lab., Tenn.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

Several new techniques have been developed for winding axisymmetrical and nonaxisymmetrical superconducting magnets. These methods make possible magnets with improved mechanical rigidity and with more reliable interconnections between coil sections (layers or pancakes). It is very important that the windings of a magnet not be allowed to move, since any motion tends to damage insulation and may lead to superconducting coil degradation. This suggests that the magnet must be wound tightly and must be free of void spaces. Techniques to make fitted void filler pieces for layer wound coils are described. These filler pieces are especially important for making interlayer transitions. Furthermore, a new method is shown for making splice free transitions between pancake sections. In pancake wound coils, such as with Nb_3Sn ribbon, splices are avoided by spiraling the conductor around tilted pins appropriately arranged. Prototype coil winding tests have shown a clear advantage in using a slight curvature on the "straight" sections of quadrupole magnets. Tests show that the curvature eliminates winding looseness which usually occurs in these parts. (auth)

24072 (LA–4250, pp G7,1-5) HIGH-FIELD CRYOGENIC MAGNETS WITH PURE ALUMINUM CONDUCTOR. Brown, Gerald V. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The use of very pure aluminum conductor in high-current-density cryogenic magnets is considered. The need to limit the strain in the aluminum by appropriate structure strength is analyzed. The conclusion is that aluminum with a resistivity ratio above 10,000 could be effectively used if the strain is limited to a few tenths of a percent. Magnetoresistance is a more serious problem at high fields than is strain resistivity. It is shown that average current densities needed to produce fields of 300 kG and over could be obtained even though large amounts of structure are needed to keep the strain low. An examination of the forces in a tape-wound solenoid shows that the problem of the low yield stress of pure aluminum can be solved by making the conductor thin and thus preventing excessive accumulation of force within the conductor. The amount of structure needed in a tape-wound coil is analyzed in terms of a nondimensional parameter containing the conductor current density and the Young's modulus of the structure. The advantage of a high modulus structure is emphasized. (auth)

24073 (LA–4250, pp G8,1-4) A STUDY OF TOROIDAL AXIALLY SYMMETRIC MAGNETIC FIELD SYSTEMS INCLUD-

ING THE EFFECTS OF FIELD DIFFUSION INTO THE RESISTIVE BOUNDARIES. Phillpott, J.; James, T. E. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

A study was made of field configurations produced by bounded axially symmetric toroidal geometries for infinite- and finite-conductivity boundary conditions. (auth)

24074 (LA-4250, pp G9.1-5) DESIGN AND CONSTRUCTION OF AN IMPROVED l = 3 STABILIZING SYSTEM FOR THE MODEL C STELLARATOR. Joyce, J. B.; Sheffield, G. V. (Princeton Univ., N. J. Plasma Physics Lab.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The magnetic features of the winding are discussed. The objective of the magnetic design was to obtain high shear and to minimize the island structure of the magnetic surfaces. Methods of adjusting the parameters of the stabilizing winding to give the desired shear, while maintaining the highest degree of magnetic symmetry, are presented. New linear circularizers were adopted that reduce the island structure and allow for adjustment of the magnetic surface quality after the windings are installed. Construction techniques are described with emphasis on new methods as compared to previous windings of this type. A description is given of the use of the vacuum tube as the inner structure for the stabilizing winding. The separate and independent supports for the circularizer windings are discussed. Magnetic, electrical, thermal, and structural specifications are listed. (auth)

24075 (LA-4250, pp G11.1-6) MINIMUM-B CONFIGURATION IN THE INTEREM FACILITY. Davis, R. C.; Luton, J. N. Jr.; Matlock, O. D.; Wright, W. L. (Oak Ridge National Lab., Tenn.).

From Proceedings of Symposium on Engineering Problems of Fusion Research.

The INTEREM facility has been modified by the addition of a pair of coils arranged to superimpose a quadrupole magnetic field on the existing mirror configuration. The coils, made of 42 turns of 0.565" × 0.565" hollow, water-cooled copper conductors, designed to carry ~5000 amperes, were cast in epoxy and mounted around a perforated copper cavity which confines the ~20 kW of applied microwave power. The coil and cavity assembly is then inserted as a unit into the INTEREM vacuum tank. The vacuum feed through seal for the current and water leads to the coils was also cast of epoxy and has been found to be reliable over many pump-down cycles. The arrangement used to restrain the coils against the magnetic forces will be described. (auth)

24076 (MATT-728) TIME-DEPENDENT BEHAVIOR OF FUSION REACTORS. Mills, R. G. (Princeton Univ., N. J. Plasma Physics Lab.). Apr 1970. Contract AT(30-1)-1238. 43p. Dep. CFSTI.

If a deuterium–tritium plasma with a temperature of about 10 keV or higher can be produced and confined under conditions such that the product of the ion density, n_i, and the confinement time, τ, is of the order of 10^{14} to 10^{15} sec-cm^{-3}, it will be physically possible to produce a nuclear-fusion chain reaction. The power required for the ignition of a thermonuclear plasma may be an important consideration for the design and economy of a plant. This power may be excessive unless the confinement time decreases as the plasma density rises, preferably in inverse proportion. Computer codes have been written to follow, in time, the development of a high-temperature reactive plasma. A variety of results using these codes is presented. (TSS) (auth)

24077 (NP-18209) MAGNETIC FIELD AND HIGH FREQUENCY INDUCTION OF A TOROIDAL ENCLOSURE. Stotland, M. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). 1969. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Equations are obtained that specify the vector potential, current density, and hf induction for a toroidal enclosure in terms of a combined system of plane and toroidal coordinates for the case when the skin layer is negligibly small. The effect of a gap in the surface of the torus is considered, and the current distribution on the surface of the torus is deduced for the case in which the gap is connected to a source of hf voltage. (tr-auth)

24078 (ORNL-TM-2895) MAGNETIC FIELD OF A CURRENT LOOP IN A TOROIDAL CONDUCTOR. Burt, P. B. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 7p. Dep. CFSTI.

In the limit of indefinitely large conductivity, the magnetic field of a current loop enclosed by a conductor is itself completely enclosed by the conductor. The total field consists of the vacuum field in the absence of walls and the field due to the image currents in the walls. The current loop must be in equilibrium with these fields. As the first step in the study of toroidal equilibria the magnetic field due to an axially symmetric current loop in the interior of a toroidal conductor of arbitrary aspect ratio, circular cross section and indefinitely large conductivity is calculated. (auth)

24079 (ORNL-TM-2945) EFFECT OF ELECTRON HEATING ON OVERALL EFFICIENCY OF CONCEPTUAL MIRROR FUSION REACTORS. Lazar, N. H.; Haste, G. R. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 11p. Dep. CFSTI.

The principal limitation to fuel confinement in conceptual mirror reactors is the rapid scattering of the ions into the loss cone following cooling by the trapped electron distribution. The ion confinement time and nuclear reaction rate were estimated as a function of electron energy, assuming the space potential resulting from the hotter electrons can be controlled. It is shown that values of Q (nuclear power produced/power injected) ≈ 3 to 4 can be attained for the principal reacting region. These values would be sufficient to obtain significant fuel heating from charged reaction products so that the overall Q could approach 10. (auth)

24080 HIGH MAGNETIC FIELDS AND THEIR APPLICATIONS. Proceedings of International Conference, Nottingham, England, 17–19 September 1969. London; Institute of Physics and Physical Society (1969). 168p. 30s. (CONF-690939).

Thirty-three papers were presented at this Conference, of which three are considered in scope for Nuclear Science Abstracts. Separate abstracts are included for these three papers. (UK)

For abstracts of individual papers see: 23900, 23901, and 23946.

24081 NUCLEAR FUSION REACTIONS IN SOLID-DEUTERIUM LASER-PRODUCED PLASMA. Floux, F.; Cognard, D.; Denoeud, L.-G.; Piar, G.; Parisot, D.; Bobin, J. L.; Delobeau, F.; Fauquignon, C. (CEA, Limeil-Brevannes, France). Phys. Rev., A; 1: 821-4(Mar 1970).

When focusing a 4-GW, fast-rise-time, nsec-range laser onto a solid deuterium target, neutron production is observed. Evidence is given for nuclear fusion reactions. The electron temperature is measured and the number of neutrons for each laser shot is estimated. (auth)

24082 EVIDENCE FOR NONTHERMONUCLEAR NEUTRON PRODUCTION IN A PLASMA FOCUS DISCHARGE. Bernstein, M. J.; Hai, F. (Aerospace Corp., El Segundo, Calif.). Phys. Lett.; 31A: 317-18(23 Mar 1970).

The measured energy spectra of D–D neutrons emitted by a plasma focus discharge are found to be inconsistent with the assumption of a thermonuclear plasma. (auth)

24083 MAGNETIC SURFACES AND DRIFT SURFACES OF AVERAGE MINIMUM B STELLARATOR FIELD. II. Miyamoto, Kenro (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 28: 1075-83 (Apr 1970).

Dependence of various quantities (rotational transform angle, shear, magnetic well depth) of the average minimum-B field of stellarator type on the geometrical parameters of the current configurations and the possible ranges of the values of these quantities are studied. These results are compared with computed ones. A condition on the ion Larmor radius and the rotational transform angle is obtained for the smallness of deviation between drift surface and the magnetic one. The effects of geometrical errors of the current configurations on the magnetic surface are analyzed numerically and a tolerance limit of error is deduced. (auth)

24084 PROSPECTS OF ENERGY GENERATION BY NUCLEAR FUSION. Szabo, Janos (Technical Univ. for Heavy Industry, Miskolc, Hungary). Fiz. Szemle; 20: 23-7(Jan 1970). (In Hungarian).

Power generation by a fission-based reactor presents the disadvantage that it creates very large amounts of radioactive waste materials. Fusion of light nuclei offers the promise to solve the energy requirements of the world on the basis of the 0.02% of deuterium in the seawater. Fusion has been successfully achieved in the hydrogen bomb but work is still in progress on the control of the fusion process. Hot plasma has been confined in "magnetic bottles," preventing the escape of hot—up to 80 million°K—ionized gas particles but only for extremely short periods. There is a continuous struggle for support between experts involved in the military and the peaceful applications of fusion energy. The role of science has changed considerably: results of the work of physicists may threaten the continued existence of the world or could eliminate the ills of hunger and poverty. The political implications of the problem are examined. (TTT)

Wave Phenomena

Refer also to abstracts 23996 and 24022.

24085 (AD-680447) JUMPS ACROSS TRANSVERSE IONIZING MHD SHOCK WAVES IN REAL HYDROGEN USING B COMPRESSION AS A PARAMETER. AN EXPLICIT DESCRIPTION OF THE STATE OF AN EQUILIBRIUM HYDROGEN PLASMA. Stebbins, Charles F.; Clawson, Duane W. (Frank J. Seiler Research Lab., USAF Academy, Colo.). Oct 1968. 25p. (SRL-68-0006). CFSTI.

The equations which describe an equilibrium hydrogen plasma with chemistry are presented as nine equations in nine unknowns. The derived state equations are applied in conjunction with the conservation equations and Maxwell's equations to predict jumps across transverse, ionizing MHD shock waves propagating into hydrogen. The jump equations were solved on a digital computer using the magnetic field compression as a parameter. This field compression, for various values of initial field, was set equal to 1, corresponding to ordinary shock waves, and was set equal to the ordinary gas compression across the shock, corresponding to pure MHD shock waves. The resulting post-shock temperature, density, electric field, and pressure as well as the mass fractions of the various plasma constituents, are presented graphically as functions of shock Mach number. The resulting curves demonstrate the interaction of the initial transverse magnetic field with the plasma, and they are useful in estimating ranges in jumps across transverse ionizing shocks without prior knowledge of the character of the shock (ordinary, immediate, or MHD). (auth) (USGRDR)

24086 (ITF-69-93) LOW-FREQUENCY ECHO OSCILLATIONS IN NONEQUILIBRIUM PLASMA. Pavlenko, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A consideration is made of the effects of temporary and spatial echo in nonisothermal nonequilibrium plasma penetrated by a compensated beam of charged particles of small density. It is shown that, with the excitation of two intensely damped short-wave oscillations, the long-wave echo oscillations can appear on the frequency of nonisothermal sound. The growth of the appearing low-frequency oscillations in time is investigated for the case of temporary echo and strengthening in space in the case of spatial echo. (auth)

24087 (SIT-2582-32) ON THE CONNECTION BETWEEN ELEMENTARY COLLECTIVE COORDINATES AND THE VLASOV EQUATION. Project CHALICE. Special Report No. 1 on Plasma Physics. Percus, Jerome K.; Yevick, George J. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). 1 Mar 1970. Contract AT(30-1)-2582. 20p. (SIT-246). Dep. CFSTI.

A naive collective coordinate analysis leads to no damping of the acoustic modes of a classical fluid. A similar analysis of the linearized Vlasov equation leads to the well-known phenomenon of Landau damping. The qualitative form of Landau damping is, however, inaccurate for nonsingular forces and probably for low-k propagation in plasmas. Comparison of the two approaches shows that retention of the velocity variable in the Vlasov equation allows for an accurate description of positional fluctuations due to velocity dispersion by itself, but a poor assessment of collective forces. If, instead, the phase mixing of collective modes due to velocity dispersion is taken into account, a damping mechanism is introduced with the anticipated hydrodynamic form in fluids at low k, and with a k^4 dependence for plasmas. (auth)

24088 (UUIP-667) STUDIES OF EQUATIONS DESCRIBING EXPLOSIVE INSTABILITIES. Weiland, Jan (Uppsala Univ. (Sweden). Inst. of Physics). Nov 1969. 11p. Dep. CFSTI (U. S. Sales Only).

A set of equations describing three wave interaction in plasmas is solved numerically for different limiting cases. Functions approximately describing the time-development of the amplitudes U_j and the phase Φ are given. In the case $\Phi(t) = \Phi_0$, where Φ_0 is a constant, the equations are solved exactly if the linear damping is identical for the three modes. For initial values deviating slightly from those which yield $\Phi(t) = \Phi_0$ the equations are solved by means of a perturbation analysis. (auth) (SW)

24089 CONTRIBUTION TO THE THEORY OF QUASI-LINEAR RELAXATION OF AN ION-ACOUSTIC WAVE SPECTRUM IN A PLASMA. Kingsep, A. S. Zh. Eksp. Teor. Fiz.; 58: 1040-5(Mar 1970). (In Russian).

The problem of relaxation of an anisotropic spectrum of ion-acoustic noise in a plasma is solved in the quasi-linear approximation. It is shown that, for a sufficient intensity of the wave spectrum, quasi-linear relaxation results in a three-dimensional spectrum changing into a one-dimensional spectrum. A self-similar solution of the quasi-linear relaxation equations that describes the process is obtained for the case of a strongly anisotropic spectrum. (auth)

24090 SELF EXCITATION OF WAVES WITH DIFFERENT POLARIZATIONS IN NONLINEAR MEDIA. Berkhoer, A. L.; Zakharov, V. E. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 58: 903-11(Mar 1970). (In Russian).

Equations are derived for the envelope waves with different circular polarizations in an isotropic nonlinear medium. The stability and self-focusing of such waves and also the stationary envelope waves are investigated. The results are applied to the problem of nonlinear electromagnetic waves in an isotropic plasma. (auth)

24091 PARAMETRIC EXCITATION OF POTENTIAL WAVES IN A COMPLETELY IONIZED PLASMA NEAR ELECTRON CYCLOTRON RESONANCE. Gradov, O. M.; Zyunder, D. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 58: 979-88(Mar 1970). (In Russian).

Parametric excitation of potential oscillations in a completely ionized plasma located in a weak uhf electric and stationary magnetic fields is considered within the framework of the kinetic theory. A dispersion equation is derived for determining the potential oscillation spectrum on basis of the kinetic equation containing a Landau collision integral. Parametric excitation of waves propagating almost along the magnetic field is investigated for the case when the external uhf field frequency ω_0 is close to the electron cyclotron frequency Ω_e. Threshold values of the uhf field strength are found above which the plasma is unstable with respect to potential oscillation build-up. It is shown that depending on the plasma parameters, a stationary magnetic field may exert a stabilizing as well as an unstabilizing effect on the instabilities. A qualitative comparison with available experimental data is made and agreement with the theoretical predictions is found. (auth)

24092 UPPER HYBRID MODE IN AN INHOMOGENEOUS PLASMA. Bhadra, Dilip K.; Pearlstein, L. D. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., A; 1: 898-905 (Mar 1970).

The dispersion of the normal mode at the upper hybrid frequency (propagating parallel to a uniform magnetic field) in a spatially inhomogeneous plasma was calculated. The perturbed potential was solved in k space for the case of a Maxwellian plasma; in the limit $k_{||} \ll k_{\perp}$, the potential function was shown to satisfy the Whittaker equation. The results obtained are in good agreement with those obtained from a recent experiment. (auth)

24093 STUDY OF TEMPORAL ECHOES IN PLASMAS BY THE RESOLVENT KERNEL METHOD. Dobbertin, Rolf (Paris Univ.). Compt. Rend., Ser. B; 270: 521-4(23 Feb 1970). (In French).

Temporal echoes appearing in a fully ionized plasma were studied, using the resolvent kernel method. This method could subsequently be applied to other kinds of instabilities, in order to avoid asymptotic methods. (auth)

24094 NONLINEAR SCATTERING OF RADIATION FROM A PLASMA. Tchen, C. M. (City Coll., New York). pp 215-31 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

In the quasi-stationary state, the wave energy, or the correlation of density fluctuations, is analyzed in its spectral decomposition for a given background distribution function, by means of a linear theory. The broadening of the lines is governed by the Landau damping. By extending to a large time scale, it was found that the wave decays or grows with twice the rate of the Landau damping. The slowly varying background is described by a diffusion equation in phase space, with the coefficient of wave diffusion depending on the wave energy. (M.O.W.)

24095 NONLINEAR INTERACTION OF ELECTROMAGNETIC RADIATION IN PLASMAS. Tzoar, N. (Bell Telephone Labs., Inc., Whippany, N. J.). pp 363-75 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The excitation of plasma oscillations by two photon beams is theoretically described. Stimulated light–light scattering in two- and three-beam systems is next discussed. (M.O.W.)

24096 MATHEMATICAL MODELS FOR NONLINEAR MODE INTERACTIONS IN BOUNDED PLASMAS. Lashinsky, Herbert (Univ. of Maryland, College Park). pp 451-76 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Mathematical models were derived that reproduce a number of physical phenomena that have been observed in experiments on instabilities in continuously operating (cw) plasma devices. The Van der Pol equation and nonlinear mode interactions are described in particular. (M.O.W.)

24097 NONLINEAR DIELECTRIC RESPONSE FUNCTION AND PARAMETRIC INSTABILITIES IN A MAGNETOPLASMA. Pomeau, Y. (Faculte des Sciences, Orsay, France). pp 479-87 of Nonlinear Effects in Plasmas. /Kalman, G. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The parametric instabilities of a plasma subjected to a pumping wave were investigated. A brief analysis is given for each of the following: (1) nonlinear polarizability, (2) determination of $\epsilon^{NL}(\omega,k)$, and (3) the Coste–Goldman approximation. (M.O.W.)

24098 NEGATIVE CYCLOTRONIC ABSORPTION IN SLIGHTLY IONIZED GASES. Gal'tsov, D. V. (Moscow Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 139-40(1969). (In Russian).

Previously, the effect of negative cyclotron absorption was used for determining the behavior of cross sections of electron elastic collisions with atoms and molecules of various gases. It is known that the negative cyclotron absorption in a nonrelativistic ($d\omega_c/dE = 0$) magnetized electron beam may appear in the case in which the frequency of electron collisions with gas atoms is a fast-increasing function of energy. Published data show that, in the case of monoenergetic and isotropic electron distribution according to the velocities, an increase of collision frequency with energies greater than E^h is required. An attempt is made to show that using an electron beam with a strongly anisotropic distribution function $f(p_\perp, p_z) = (1/2\pi p_\perp)\,\delta(p_\perp - p'_\perp)\delta(p_z - p'_z)$ the threshold magnitude h can be reduced to $h > 2$ (showing that the negative absorption may begin with $h > 2$), which is in agreement with the conclusions offered by D. V. Gal'tsov (Izv. Vyssh. Ucheb. Zaved., Fiz: No. 3, 144(1968)) and the minimum possible threshold magnitude when $h = 2$. (R.V.J.)

Shielding

24099 (HASL-221) SHIELDING CALCULATIONS FOR BROAD NEUTRON BEAMS NORMALLY INCIDENT ON SLABS OF CONCRETE. O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan 1970. 10p. Dep. CFSTI.

The validity of the P_3 spherical harmonics method of calculating neutron transport was checked by comparison with results obtained at Oak Ridge using Monte Carlo and discrete ordinates methods. Neutron transport calculations were then carried out to obtain the neutron dose-equivalent transmitted through slabs of concrete up to 2000 g/cm^2 thick by normally incident beams of 50, 100, 150, 250, and 350 MeV. (auth)

24100 (KAPL-P-3848) EXPERIENCE WITH LAGUERRE NUMERICAL INTEGRATION IN POINT KERNEL SHIELDING CALCULATIONS. Mesh, D. W.; Cochrane, P. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec 1969. Contract W-31-109-eng-52. 11p. (CONF-691102-5). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

The equation for the radiation from a monoenergetic line source in a shield with a constant attenuation coefficient is given. An attempt is made to streamline numerical evaluation of the equation with a Gaussian–Laguerre integration procedure. The technique concentrates virtual source points (or quadrature points) where the integrand is largest, at the front of the source (i.e., nearest the detector). The accuracy of the Laguerre procedure is compared with the symmetric Gauss–Legendre method. (M.H.R.)

24101 (ORNL-4464) NEUTRON AND SECONDARY GAMMA-RAY TRANSPORT IN INFINITE HOMOGENEOUS AIR. Straker, E. A.; Gritzner, M. L. (Oak Ridge National Lab., Tenn.). Dec 1969. Contract W-7405-eng-26. 411p. Dep. CFSTI.

The detailed energy, angular, and spatial distribution of neutrons and their secondary gamma rays is given for nine source energy groups, a fission spectrum, and a typical thermonuclear spectrum. Results for ranges to 2000 meters for the eleven sources are supplemented with results to 5000 meters for a fission and 12.2- to 15-MeV source. In addition to the detailed description of the radiation field, the angular distributions of Henderson dose, Snyder–Neufeld dose, tissue kerma, mid-phantom dose, concrete kerma, air kerma, ionizing silicon kerma, and non-ionizing silicon kerma are given for neutrons, and the Henderson dose, concrete kerma, air kerma, and silicon kerma are given for secondary gamma rays. Some comparisons with air-over-ground results are made. (auth)

24102 (ORNL-RSIC-28) COMPARISONS OF THE RESULTS OBTAINED WITH SEVERAL ELECTRON-PENETRATION CODES. Scott, W. Wayne (Oak Ridge National Lab., Tenn.). Mar 1970. 13p. Dep. CFSTI.

Comparisons of the results obtained for several similar hypothetical problems using electron-penetration codes available from the Radiation Shielding Information Center are presented. These codes are designed to determine the tissue surface dose as a function of shield thickness. Transmitted electron spectra from those codes which provide such spectra are also compared. Significant differences between the results given by the various codes are found. (auth)

24103 (ORNL-tr-2202) IONIZATION IN THE INTERIOR OF A SATELLITE BY BREMSSTRAHLUNG PRODUCED BY THE ELECTRON COMPONENT OF VAN ALLEN RADIATION. Baeuerlein, R. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report BMwF-FB-W-69-04. 27p. Dep. CFSTI.

A method is described for determining the ionization occurring in a silicon component behind a shield of given mass thickness due to the bremsstrahlung produced in the outer skin of a satellite by the electron component of the Van Allen radiation. With a typical electron spectrum, the ionization due to the bremsstrahlung is generated predominantly by low-energy electrons. Compared with the ionization due to direct radiation, the ionization in the inner Van Allen belt due to bremsstrahlung is negligible, whereas in the range of the outer radiation belt it predominates from mass thicknesses of several g/cm^2 onwards. (auth)

24104 (UCRL-19345) THE THERMAL NEUTRON FLUX PRODUCED IN A SPHERICAL AND A CUBICAL CAVITY BY SLOWING DOWN OF FAST NEUTRONS IN THE CAVITY WALLS, FOR WALLS OF WATER AND CONCRETE, AS A FUNCTION OF CAVITY SIZE, USING THE DISCRETE S_n METHOD. Lim, Chun Bin (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1969. Contract W-7405-eng-48. 87p. Dep. CFSTI.

Thesis.

The slow-neutron flux in a cavity in some moderating materials like water and concrete is presumed to be quite uniform throughout the cavity when a fast-neutron source (~ 2.5 MeV) is located at the geometrical center point. This uniformity may be used to good advantage in some places, like in the calibration of slow-neutron detectors, for example. An attempt is made to see how flat it is in the actual case through computer calculations, and, further, to figure out the relation between the slow-neutron flux level in the cavity and the inner cavity surface area of the spherical shell, using the discrete S_n method, an approximate method to solve the neutron transport equation. In running these problems with ANISN code, the sixteen group, PO, cross-section data (up to P1 term in hydrogen) of 1/E weighting was used. Later, an attempt is made to get the approximate level of the slow-neutron flux in the case of a cubical cavity by replacing it with an equivalent spherical cavity. (auth)

24105 ANALYSIS AND MEASUREMENTS OF NEUTRON STREAMING IN DUCTS. Barrett, Matthew Joseph. College Park, Md.; Univ. of Maryland (1969). 146p.

Thesis.

An experimental and analytical study of the effects of ducts through neutron shields was performed. Results were described by a transmission probability T, which was defined as the ratio of the number of neutrons leaving the duct from its exit end to the number of neutrons going into the entrance end of the duct. This transmission probability was broken into three terms: one due to neutrons traversing the duct without collisions, a second term due to neutrons streaming through the duct with one or more scattering collisions with the nuclei of the duct walls, and a third term due to neutrons penetrating the shield and entering the duct through its walls. Bent ducts are analyzed in terms of these transmission probabilities for straight ducts. The transmission probability for a bent duct is the product of the individual probabilities of transmission in each straightline segment and the probabilities of scatter to turn each corner. Energy of the neutron is found to be especially significant for bent ducts. Experiments with a neutron source and ducts of various geometries in graphite and concrete were performed to examine the applicability of the theoretical treatment. The source was shielded so that the spectrum of the neutrons entering the duct would simulate that of a fission source. A BF_3 detector was covered with paraffin to improve its sensitivity to fast neutrons, and cadmium sheets were used when it was desired to block out thermal neutron streaming. The results obtained were correlated with aspects of the theory: (a) neutrons reflect from duct walls in an angular distribution that is cosine-distributed around the normal to the wall surface, (b) wall-scattered streaming generally falls off initially as the inverse square of the duct length, but tending to the inverse cube of the duct length in longer ducts, (c) neutron moderation is significant, especially in bent ducts, and (d) the probability that streaming neutrons will turn a bend depends on their energy spectrum and, hence, on the length of duct before the bend. (Diss. Abstr.)

24106 CALCULATION OF THE ENERGY DEPOSITED BY NUCLEONS IN A SPHERICAL PHANTOM AND COMPARISON WITH EXPERIMENT. Irving, D. C.; Alsmiller, R. G. Jr.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 37: 304-6(Aug. 1969).

Transport calculations were made using the nucleon transport code NTC and compared with the experimental data of Maienschein on the energy deposition in a spherical water-filled phantom by 160-MeV protons alone (Traverse A) and after interacting with an Al target of thickness 26.9 g/cm^2 (Traverse B). The results are plotted on absorbed dose vs depth graphs. The calculated doses arise from particles produced by nucleon–nucleon collisions. At the center of the phantom, the calculated doses are higher than the experimental doses. (D.L.C.)

24107 ON THE INFLUENCE OF ATOMIC NUMBER AND DENSITY IN MATERIAL STUDIES BY BACKSCATTERING OF QUANTUM RADIATION. Dahn, E. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis; 5: 252-6(Jul 1969). (In German).

On the basis of a single scattering model, the intensity of backscattered gamma radiation is calculated as a function of density and atomic number of the scattering material. (auth)

24108 OPTIMIZATION OF MEDIUM SHAPE WITH THE PRESENCE OF RADIATION. Abagyan, A. A.; Petrov, E. E.; Pupko, V. Ya. At. Energ. (USSR), 27: 200-4(Sept. 1969). (In Russian).

A new concept of efficiency function of volume element on medium surface in regard to a linear functional of radiational flux is given. The expression for the efficiency function is obtained on the basis of perturbation theory with the application of adjoint functions. The condition of the optimum medium shape with respect to the minimum of any linear functional under definite restrictions is derived in terms of classical variational calculus. To illustrate the practical application of this condition, the example of the optimum shield shape calculation in the case of the point isotropic source is considered. The concept of the efficiency function can be useful in resolving more general problems in which there are supplementary limitations for the medium dimensions. (auth)

Solid-State Physics

Refer also to abstracts 22665, 23038, 23039, and 24659.

Radiation Effects

Refer also to abstracts 23047, 23049, 24306, and 24487.

24109 (COO–1800-8) THERMAL CONVERSION OF INTERSTITIALS. Simpson, H. M.; Sosin, A. (Utah Univ., Salt Lake City). [1969]. 11p. Dep. CFSTI.

The observations of Thompson and Buck (Phys. Status Solidi, to be published) on dislocation pinning in gamma-irradiated Cu are summarized. The model proposed by Bauer et al., in which interstitials are the mobile Stage I defect and undergo thermal conversion to immobile Stage III defects, is shown to be reasonable. The Stage I defect is visualized as an interstitial with axis along the ⟨111⟩ direction and capable of three-dimensional diffusion; the Stage III defect is the ⟨100⟩-oriented interstitial (dumbbell). Equations are derived for the pinning rate in this model, and the impurity trapping term is shown to be responsible for the wide range of pinning rates (factor of 10^5) between 80 and 400°K. Excellent agreement with the data of Thompson and Buck is found. (D.L.C.)

24110 (HMI-B-90) INVESTIGATION OF THE INFLUENCE OF IONIZING IRRADIATION ON THERMALLY OXIDIZED SILICON SURFACES BY MEANS OF THE FIELD EFFECT. Wagemann, H. G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Nov 1969. 136p. (In German). Dep. CFSTI (U. S. Sales Only).

Starting with the process of thermal oxidation of silicon, the positive charge of the oxide layer (interface charge) and of the interface between oxide and semiconductor (interface states) is discussed. They are evaluated experimentally by means of the field effect admittance and of the noise current before and after irradiation. The results indicate that the density of surface states increases without changing its energy distribution. The interface states at the middle of the band gap prove to be surface recombination centers; those close to the energy E_L of 0.16 eV may be attributed to a Si A-center of the interface. (auth)

24111 SPUTTERING OF TANTALUM AND TANTALUM–NIOBIUM SINGLE CRYSTALS. Dubinskii, V. E.; Lebedev, S. Ya.; Rodionova, V. G. Sov. Phys.-Solid State (Engl. Transl.); 11: 2037-40(Mar 1970).

Translated from Fiz. Tverd. Tela; 11: 2526-9(Sep 1969).

The {111} plane of tantalum and Ta–25 at. % Nb single crystals was bombarded with 70-keV Ar ions arriving at the target perpendicular to the surface. The sputtering products were deposited on a semicylindrical cooled glass collector. The collectors were examined in a microphotometer with the aid of a special attachment. It was found that the sputtering patterns for temperatures of 95 and 290°K were similar to one another and also similar to the patterns of tungsten and molybdenum. The curve relating the optical density of the deposit to the angle measured in the {110} plane showed a rise in density near the ⟨111⟩ directions at angles of 0 and +70° to the surface normal and near the ⟨100⟩ directions at an angle of 50°. The maximum density deviated by 5° in the perpendicular direction from the ⟨100⟩ direction; the reasons for this are discussed. (auth)

24112 175° K RECOVERY STAGE IN IRRADIATED p-TYPE SILICON. Cheng, L. J.; Lori, J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Lett.; 31A: 281-2(9 Mar 1970).

The 175°K recovery stage observed in irradiated high-resistivity p-type silicon is not affected by the presence of a high concentration of oxygen, contradicting the thought that the migration of the neutral vacancy is responsible. (auth)

24113 ION MASS EFFECT IN CHANNELING. Foti, G.; Grasso, F.; Quattrocchi, R.; Quercia, I. F.; Rimini, E. (Univ., Catania, Italy). Phys. Lett.; 31A: 214-15(23 Feb 1970).

An experimental difference between backscattered yield profiles of channeled 0.3 MeV H^+ and D^+ on Si was measured and tentatively attributed to multiple scattering. (auth)

24114 A STUDY ON BACKSCATTERING OF PROTONS FROM Ge SINGLE CRYSTALS. Morita, K.; Itoh, N. (Nagoya Univ., Japan). Phys. Lett.; 31A: 283-4(9 Mar 1970).

The energy spectrum of the backscattered protons from Ge single crystals is studied. The stopping power ratio of the aligned beam to the random beam, the transition probability from the aligned to the random beam, and the critical angles are obtained. (auth)

24115 AUTO-ION MICROSCOPY OF DEFECTS IN TUNGSTEN SINGLE CRYSTALS DUE TO α-PARTICLE BOMBARDMENT. Suvorov, A. L.; Kukavadze, G. M.; Bobkov, A. F. Zh. Eksp. Teor. Fiz.; 58: 85-7(Jan 1970). (In Russian).

Tungsten crystal imperfections due to bombardment with α particles from 12.7 to 23.4 MeV are investigated at 78°K. The doses varied between 1.7×10^{15} and 1.6×10^{16} particles /cm^2. Four main types of imperfections were observed in the irradiated samples: single vacancies, atoms displaced to interstitial positions, vacancy clusters of ~10 Å diameter, and small complexes of displaced atoms on the surface. (auth)

24116 TECHNIQUE USED IN HALL EFFECT ANALYSIS OF ION-IMPLANTED Si AND Ge. Johansson, N. G. E. (California Inst. of Tech., Pasadena); Mayer, J. W.; Marsh, O. J. Solid-State Electron.; 13: 317-35(Mar 1970).

Hall effect and sheet resistivity measurements are commonly used to evaluate ion-implanted layers. A description is given of the general principles, sources of error, and factors influencing the measurements. Implantation conditions, sample preparation, and measurement technique used for van der Pauw geometry are discussed. Considerations important in annealing, layer removal, and measurement temperature are also discussed. Some results are given for Si and Ge. (auth) (UK)

24117 ION IMPLANTATION PANEL REPORT. Dearnley, G. London; Science Research Council (1970). 66p.

The field of ion implantation is examined and, where relevant, the more general field of atomic collision processes in solids, the aim being to establish whether the subject, scientifically and technologically, merits special encouragement. Current research activities and future trends are noted. (UK)

24118 80 TO 140°K ANNEALING STAGE OF p-TYPE GERMANIUM AFTER IRRADIATION WITH 1.5-MeV ELECTRONS AT 77°K. Fukuoka, Noboru; Saito, Haruo; Tatsumi, Yukichi (Osaka Univ.). Jap. J. Appl. Phys.; 8: 1573-4(Dec 1969).

Information on the 80 to 140°K annealing of irradiated Ge doped with Ga or In is summarized. The activation energy for this stage is 0.1 eV, and this stage occurs in the dark. The annealing change in electrical properties is larger for In-doped Ge than for Ga-doped Ge, and this is ascribed to the dopant atom size. A model for the annealing stage is proposed: vacancies migrate and associate with substitutional impurity atoms, resulting in an E-center-like complex. (D.L.C.)

24119 THEORY OF CHANNELING EFFECTS. I. Kagan, Yu.; Kononets, Yu. V. Zh. Eksp. Teor. Fiz.; 58: 226-44(Jan 1970). (In Russian).

A consistent method for analysis of channeling and related effects based on the density matrix formalism is developed, and permits one to single out in a consistent manner coherent diffraction due to regularity of the medium. In the case of plane channeling, and neglecting inelastic scattering, the problem reduces to that of motion of a particle in a one-dimensional periodic potential $V_{eff}(x)$, which depends on the crystal temperature. States whose energies are close to the maximal values of $V_{eff}(x)$ are found to play an important role. The distance from the input surface, over which significant change of the nuclear reaction yield occurs, is studied. It is shown that spikes of the nuclear reaction yield with increase of the crystal thickness (resembling an "echo") may appear. A specific analysis is carried out for a model potential of the Kronig–Penney type. The calculations yield all the qualitative results and, in particular, demonstrate the quantum oscillations of the nuclear reaction yield averaged over the thickness as a function of the angle of incidence. (auth)

24120 INVESTIGATION OF COLOR CENTERS IN ALKALI HALIDE CRYSTALS AT THE ELECTRON MICROSCOPE LEVEL. Distler, G. I.; Lebedeva, V. N.; Moskvin, V. V. (Inst of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 14: 559-65(Jan-Feb 1970).

Translated from Kristallografiya; 14: 664-71(Jul-Aug 1969).

The distribution of color centers in x-irradiated NaCl crystals was revealed by use of the electron microscope decoration method. It was shown that the density of gold decorant increased on the surface of irradiated NaCl crystals, thereby leading to the formation of new color centers. The nucleation centers took the form of both single and complex centers, occurring as groupings and aggregates. The amount of gold decorant with (100) orientation was increased in colored NaCl specimens. (auth)

24121 CHARACTERISTICS OF RADIATION COLOR CENTERS AND MICROISOMORPHISM IN CRYSTALS. Samoilovich, M. I.; Tsinober, L. I. (All-Union Scientific-Research Inst. of Glass and Molecular Compounds, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 14: 656-66(Jan-Feb 1970).

Translated from Kristallografiya; 14: 755-66(Jul-Aug 1969).

A review is presented of problems associated with the study of radiation color centers in various minerals. The latest physical methods of studying structural impurities, chiefly electron paramagnetic resonance (EPR) and optical spectroscopy, have revealed a close relationship between color centers and various kinds of microisomorphic substitutions in crystals. Advances in the theory of molecular orbits, particularly in its application to ion radicals, enable one to establish a link between EPR and optical spectroscopic data. This review presents some information regarding color centers in quartz, calcite, tournaline, danburite, aragonite, barytes, celestine, ambigonite, apophyllite, apatite, fluoropholog-opite, albite, scapolite, and a number of other minerals in relation to the characteristics of their impurity composition. It is shown that the introduction of impurity into a crystal in structural form causes a charge redistribution, and this necessarily leads to the appearance of places with locally uncompensated charge in the crystal; these capture electrons and holes, forming color centers. (auth)

24122 LATTICE PARAMETER AND RESIDUAL ELECTRICAL RESISTIVITY CHANGE IN NEUTRON-IRRADIATED COPPER. Himmler, U.; Peisl, H.; Sepp, A.; Waidelich, W.; Wenzl, H. (Technische Hochschule, Darmstadt, Ger. Technische Hochschule, Munich). Z. Angew. Phys.; 28: 175-81(1 Dec 1969). (In German).

Pure copper was irradiated at 4.6°K with fast neutrons. Change of lattice parameter and residual electrical resistivity was measured after various irradiations and after annealing. The ratio of relative lattice parameter change to resistivity change decreases with increasing irradiation dose. Thermal annealing of lattice parameter change takes place at the same temperatures as annealing of resistivity change. The relative amount of lattice parameter change annealing in stage I (4 to 60°K) decreases with increasing dose. The relative amount of change in the various annealing stages is different for lattice parameter and resistivity change. An annealing mechanism is proposed. (auth)

24123 ON THE DERIVATION OF THE RANGE EQUATION FOR ENERGETIC PARTICLES IN AMORPHOUS MATERIALS. Mazur, P. (Instituut-Lorentz, Leiden); Sanders, J. B. Physica, 44: 444-8(Sept. 29, 1969).

An equation, governing the behavior of energetic projectiles in amorphous target material, is derived on the basis of the hypothesis that this behavior can be represented by a Markoff process. (auth)

24124 CHARGED-PARTICLE TRACKS IN SOLIDS. Morgan, D. Vernon (Atomic Energy Research Establishment, Harwell, Eng.); Van Vliet, Dirck. Contemp. Phys.; 11: 173-93(Mar 1970).

When energetic heavy ions such as fission fragments pass through some solids, linear trails of damage (tracks) mark their trajectories. A review is presented of the large number of experimental observations of track structure in solids, and the track-storing ability of a solid in relation to the electronic excitation of the bombarding ion and to a number of physical properties of the solid is shown. Two models, "The Electron Thermal Spike" and "The Ion Explosion Spike," proposed to account for track formation are considered in the light of these results. A number of practical applications of the track-forming process are reviewed. (auth) (UK)

24125 A NEW DIELECTRIC RELAXATION PEAK IN X-IRRADIATED COBALT-DOPED NaCl CRYSTALS. Jain, S. C. (Solid State Physics Lab., Delhi); Lal, Krishan. J. Phys., C (London); 3: L39-40(Feb 1970).

On x-irradiation, cobalt-doped NaCl crystals show a new relaxation loss peak, designated as an S peak. The S loss peak occurs on the higher frequency side of the A and B loss peaks observed in unirradiated crystals. The intensity of the S loss peak increases with the dose of x-irradiation and with the concentration of cobalt. The dc conductivity and heights of A and B loss peaks decrease with the creation of S centres. On heating the x-irradiated crystals to about 200°C, the S centres disappear and the conductivity and the heights of the A and B peaks are partially restored to their original value. A possible model for S centres is mentioned. (auth) (UK)

24126 MECHANISM OF LUMINESCENCE EXCITATION BY IONIC BOMBARDMENT. Baklitskii, B. E.; Parilis, E. S. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 85-7(Jul 1969).

Translated from Opt. Spektrosk.; 27: 169-72(Jul 1969).

Equations are given for the elastic and inelastic energy losses of an ion beam on crystal phosphors, and for the luminescence yield L. The dependence of L on ionic velocity and on the type of ion and phosphor atom (at different velocities) is examined and shown to be determined mainly by the mechanism of electronic excitation by collision with ions. Thus, L must be affected by the crystal structure of the phosphor. For ZnS, the L vs. angle of incidence curve is calculated and found to exhibit several minima and maxima. (D.L.C.)

24127 CROSS SECTION FOR THE EXCITED ABSORPTION OF URANYL IONS. Abramova, I. N.; Abramov, A. P.; Tolstoi, N. A. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 293-5(Sep 1969).

Translated from Opt. Spektrosk.; 27: 540-2(Sep 1969).

Absorption of light by excited uranyl ions results in the formation of photogenic luminescence quenching centers (PQC), with a concentration of $B\sigma^* nE$ (B = probability for formation of PQC; n = concentration of excited uranyl ions; and E = light intensity). Absolute value measurements of σ^* were made for ZhS-9 uranyl glass, uranyl sulfate, and cesium uranyl sulfate. σ^* was found to be large, in the range 10^{-16} to 10^{-17} cm^2. This indicates that the B value is small ($<10^{-3}$), i.e., the fraction of direct excitations resulting in the formation of PQC is negligible in comparison with the total number of excitations participating in luminescence. (D.L.C.)

24128 ON THE PRODUCTION OF F-CENTRES BY FAST ELECTRONS. Choudhury, A.; Goswami, K.; Chaudhuri, S. (Jadavpur Univ., Calcutta). Nuovo Cim.; 66B: 30-2(11 Mar 1970).

A single crystal of NaCl was bombarded with 25-keV electrons along its (100) axis, and the corresponding depth of coloration due to F-centers was estimated. The number of F-centers produced was compared with the number of incident electrons, and the rate of F-center production was found to be 52%. (auth)

24129 SMALL-ANGLE X-RAY SCATTERING FROM NEUTRON-IRRADIATED SINGLE-CRYSTAL LITHIUM FLUORIDE. Telegina, I. V.; Kolontsova, E. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 187: 566-8(July 21, 1969). (In Russian).

Single crystals of LiF were given integral neutron doses of 1.5×10^{17}, 9×10^{17}, 3 to 8×10^{18}, and 10^{19} neutrons/cm^2. Information on the space distribution of intensity near the zero mode of the reverse lattice was obtained at various orientations of the crystal. Only a weak, hardly noticeable, isotropic scattering was observed in samples having a dose of 1.5×10^{17} n/cm^2. Anisotropic scattering was observed in crystals having a large irradiation dose (3 to 8×10^{18} n/cm^2). The anisotropic scattering was expressed in the form of dashed lines of two types parallel to the (100) and (111) directions. The intensity along the dashed lines decreases in a monotonic manner with increasing distance from the center of the x-ray picture. A complete disappearance of the isotropic scatter-

ing lines in the (100) and (111) directions at zero node was observed on increasing irradiation dose to 10^{18} n/cm². Only two-dimensional effects associated with plane disturbances parallel to the (100) direction could be observed. It is believed that both types of two-dimensional diffractional effects in the (100) and (111) directions have the same origin and are caused by plane accumulations of vacancies or gaseous decay products in the (100) and (111) planes. Thus from this study, it is possible to understand the data obtained by diffusion scattering, and to describe the secondary defects which are formed as a result of the interaction of point defects, whose concentration and mobility increase with increasing degree of irradiation. (TTT)

24130 INVESTIGATION OF ELECTRON TRAPPING PHENOMENA IN METAL OXIDE INSULATORS. Pickard, Paul Shiflet. Tucson, Ariz.; Univ. of Arizona (1969). 132p.

Thesis.

Electron trapping phenomena in metal oxide insulators were investigated both theoretically and experimentally by the method of thermally stimulated currents (TSC). A theoretical model from energy band theory was developed and used as the basis of a general analysis which described the currents resulting from thermal stimulation for arbitrary retrapping rates. This analysis employed the concept of an "effective" thermal emission probability (ETEP). A general expression was obtained for the TSC curve which reduced to previous approximations in the limits of slow and fast retrapping. An equation was derived from the ETEP analysis which can be used to calculate the trap cross section when fast retrapping occurs, which previously had not been possible. A method of obtaining the carrier mobility from TSC data was also developed from this general analysis. A series of thermally stimulated current measurements was performed on polycrystalline Al_2O_3, BeO, and single-crystal Al_2O_3. A special cryostat was constructed for these experiments. A 1-MeV electron accelerator was used as the x-ray source. Samples were irradiated at about 200°K to fill the trapping levels, and the electrical conductivity of the samples monitored while heating at a linear rate to about 675°K. Experimental results on these metal oxide materials revealed a significant density of energy levels in the forbidden band which function as electron trapping centers. The emptying of discrete trapping levels while heating at a linear rate caused peaks to occur in the conductivity versus temperature curves. These peaks in the conductivity data were accompanied by a fairly uniform TSC current arising from the emptying of trapping levels distributed in energy throughout the forbidden band. These TSC curves were analyzed to determine trap depths, trap densities, and cross sections, and recombination and mobility parameters. The results of the analysis revealed trap densities ranging from 2×10^{18} cm^{-3} for the polycrystalline Al_2O_3 to 5×10^{16} cm^{-3} for the single-crystal Al_2O_3. Discrete levels were observed to have trap depths in the range of 0.5 eV to 1.5 eV with cross sections varying from 10^{-15} cm² to 10^{-21} cm². The value of the mobility obtained from the data on polycrystalline Al_2O_3 at 600°K was 0.2 cm²/volt-sec. The density of recombination centers was calculated to be 2×10^{18} cm^{-3} with a recombination capture cross section of 5×10^{-17} cm². The magnitude of the conductivity caused by the emptying of traps varied from 10^{-14} to 10^{-12} (ohm-cm)$^{-1}$. The current observed with no prior irradiation corresponded to an equilibrium room temperature conductivity of 5×10^{-16} (ohm-cm)$^{-1}$. (Disser. Abstr.)

24131 EFFECT OF ADSORPTION OF KNOWN MONOLAYERS ON THE KINETIC ELECTRON EMISSION AND IONIC REFLECTION OF A MOLYBDENUM TARGET BOMBARDED BY RARE GAS IONS. Perdrix, M.; Baboux, J. C.; Goutte, R.; Guillaud, C. (Institut National des Sciences Appliquees, Villeurbanne, France). J. Phys., D (London); 3: 594-600 (Apr 1970). (In French).

A study was made of the variations of the coefficients of kinetic electronic emission and ionic reflection of a Mo target bombarded by He^+ and Ar^+ ions with the formation of a hydrogen, oxygen, or potassium monoatomic layer. First, the time necessary for the building up of a monoatomic layer is determined; the electronic emission and ionic reflection are then studied as a function of time with incident ions of various energies. Finally, the variations of the electronic emission are explained by the changes in work function caused by adsorption. (auth) (UK)

24132 RADIATION EFFECTS. Aukerman, L. W. (Aerospace Corp., Los Angeles). pp 343-409 of Semiconductors and Semimetals. Vol. 4. /Willardson, R. K. (ed.). New York; Academic Press Inc. (1968).

In this review of radiation effects in III-V compounds, the creation of atomic displacements by energetic particles and the recovery of the damage are first discussed. Threshold experiments on all the compounds are discussed, and energy levels and various methods for determining them are treated. Radiation damage properties are discussed for each compound: InSb, InAs, GaAs, GaSb, AlSb, and InP. Finally, radiation damage in devices are considered. (D.L.C.)

24133 ION IMPLANTATION IN SEMICONDUCTORS. Mayer, James W. (California Inst. of Tech., Pasadena); Marsh, Ogden J. pp 239-342 of Applied Solid State Science. /Wolfe, Raymond (ed.). New York; Academic Press Inc. (1969).

A review is presented of the concepts and characterization of ion implantations in Si, Ge, and other semiconductors. Ion range distributions, lattice disorder, location of implanted atoms, and electrical properties are discussed. Applications of ion implantation to device fabrication (junctions, transistors, and junctions in compound semiconductors) are considered. 177 refs. (D.L.C.)

24134 ETCHING OF SUBMICRON PORES IN IRRADIATED MICA. Bean, C. P.; Doyle, M. V.; Entine, G. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys.; 41: 1454-9(15 Mar 1970).

As discovered by Price and Walker, small uniform pores may be created in muscovite by etching in HF thin samples that have been subjected to fission particle irradiation. The process of pore growth is followed by monitoring the conductance across a thin sample as the etching proceeds. For irradiation with ^{252}Cf the tracks quickly etch to a radius of 33 Å—the region of primary damage. Further radial etching in the undamaged material is slow but increases to a fixed rate as the radius increases. This radius dependence of etching is interpreted by a kinetic analog of the Kelvin equation for vapor pressure over curved surfaces. With suitable assumptions on the mechanism of attack, the surface energy of the muscovite–solution interface is calculated to be about 300 ergs/cm². (auth)

24135 PROTON SPUTTERING OF GOLD. Furr, A. Keith; Finfgeld, C. R. (Virginia Polytechnic Inst., Blacksburg). J. Appl. Phys.; 41: 1739-42(15 Mar 1970).

Sputtering of gold by normally incident protons of energies between 500 eV and 8 keV was studied. An ion source system delivering a magnetically analyzed proton beam to a target at a pressure of 5×10^{-8} torr was utilized, and neutron activation established the quantities of sputtered material. The gold targets, consisting of microcrystals with preferred orientation, were sputtered predominantly on (100) and (110) planes, and the yields were not observed to depend perceptibly on the crystal orientation. The yield was a maximum of 0.022 atoms/proton at a proton energy of 4 to 5 keV, dropping off gradually at higher energies and sharply at lower ones. Analysis of the sputtered deposit spot patterns, using autoradiographs, indicated that focused collision sequences were of greater importance in proton sputtering than in sputtering by heavier ions. A readily detectable yield for sputtering by 500-eV protons suggests a minimum atomic ejection energy of less than 10 eV for sputtering of gold. (auth)

24136 EPR STUDY OF A PARAMAGNETIC CENTER FORMED BY OXYGEN ADSORPTION ON A SITE CREATED FROM γ IRRADIATION OF SILICA–ALUMINA. Vedrine, J.; Dalmai, G.; Imelik, B. (Institut de Recherches sur la Catalyse, Villeurbanne, France). pp 304-12 of Magnetic Resonance and Radiofrequency Spectroscopy. Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Co. (1969). (In French).

From 15th Ampere Colloquium, Grenoble, France. See CONF-680901.

One of the numerous paramagnetic centers observed at 82°K on γ-irradiated silica–alumina was isolated by heating this sample to room temperature. This center, E_1', was identified as an electron trapped by a surface anion–cation vacancy of silica network ($g_1 = 2.003$, $g_2 = 2.002$, and $g_3 = 1.998$). A fast irreversible adsorption of oxygen takes place at 82°K on it and a new ESR signal is observed with $g_x = 2.0022$, $g_y = 2.0068$, and $g_z = 2.024$. This spectrum was identified as an O_2^- species bonded by electrovalency to a Si^{4+} ion adjacent to an E_1' center. (auth)

Physical Properties

Refer also to abstracts 23424, 23481, 23513, and 23763.

24137 (BNL-14556) LOW TEMPERATURE IRON MEASUREMENTS. McInturff, A.; Claus, J. (Brookhaven National Lab., Upton, N. Y.). [nd.] 20p. (CONF-700503-1). Dep. CFSTI.

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

Magnetic measurements were made on low-carbon steel, 1.8% Si steel, and 3.25% Si steel at 4.2, 77, and 300°K, using magnetic fields up to 2.2 kOe. The magnetization and μ values are tabulated. Hysteresis loops and coercive force were also measured. The steels were found to be anisotropic, with μ_{max} being highest for samples cut in the rolling direction of the sheets. (D.L.C.)

24138 (UCRL-50174(Sect.4)) COMPILATION OF X-RAY CROSS SECTIONS. SECTION IV. McMaster, W. H.; Del Grande, N. Kerr; Mallett, J. H.; Hubbell, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1969. 40p. Dep. CFSTI.

This section contains tables of cross section values evaluated at the energies most used by x-ray crystallographers, ranging from 1.7444 to 9.5720 keV. The cross sections are expressed in barns/atom and cm^2/g for Z = 1 through 94. (D.L.C.)

24139 ENERGY DISTRIBUTION OF PHOTOELECTRONS OF GADOLINIUM AND TERBIUM. Nemchenok, R. L.; Strakovskaya, S. E.; Titenskii, A. I. (Leningrad Polytechnical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 11: 2181-2(Mar 1970).

Translated from Fiz. Tverd. Tela; 11: 2692-4(Sep 1969).

Photoemission measurements were performed on Gd and Tb for photon energies $h\nu$ of 3.4 to 4.9 eV, and energy distributions of the photoelectrons were obtained. The work function was determined to be 2.9 ± 0.1 and 3.0 ± 0.1 eV for Gd and Tb, respectively. The energy distribution curves for the two metals were similar for photon energies ≤ 4.4 eV, with a single maximum that increases with $h\nu$. For Gd and $h\nu$ = 4.7 and 4.9 eV, a second maximum appears; this is in agreement with the density of electron states of Gd. (D.L.C.)

24140 EFFECT OF A MAGNETIC FIELD ON THE ELECTRICAL AND THERMAL CONDUCTIVITIES OF HOLMIUM. Nikol'skii, G. S.; Zvyagina, N. M.; Eremenko, V. V. (Physical Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 11: 2009-13(Mar 1970).

Translated from Fiz. Tverd. Tela; 11: 2489-94(Sep 1969).

An experimental investigation of the low-temperature electrical and thermal resistivities of polycrystalline holmium in a magnetic field is reported. An analysis of the results leads to the conclusion that magnons play a negligible role in heat transport processes. The behavior of the temperature dependence of the electrical and thermal resistivities in magnetic fields up to 22 kOe is discussed. (auth)

24141 HALL COEFFICIENT, ELECTRICAL RESISTIVITY, AND MAGNETIC SUSCEPTIBILITY OF LIQUID Ce. Busch, G.; Guenthordt, H. -J.; Kuenzi, H. U.; Schlapbach, L. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 31A: 191-2 (23 Feb 1970).

The Hall coefficient, the electrical resistivity, and the magnetic susceptibility of cerium were measured in the liquid and in the solid state. A positive Hall coefficient was observed in the liquid state. The results are in good agreement with available data at lower temperatures. (auth)

24142 MAGNETIC PROPERTIES OF URANIUM AND THORIUM COMPOUNDS CONTAINING IRON, NICKEL, OR COBALT. Chechernikov, V. I.; Pletyushkin, V. A.; Shavishvili, T. M.; Slovyanskikh, V. K. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 58: 80-4(Jan 1970). (In Russian).

The magnetic susceptibility was measured for the following: UFe_2, UCo_2, UNi_5, ThNi, $ThNi_5$, $ThCo_5$. Compounds that are isomorphic with respect to their crystal structure are found to possess different magnetic properties. Thus, UFe_2 and $ThCo_5$ are ferromagnetic substances, whereas UCo_2 and$ThNi_5$ are temperature-independent paramagnetic substances. The rigid-band model is employed for interpreting the results obtained. (auth)

24143 INVESTIGATIONS ON THE RESISTIVITY OF THE COMPOUND $CeAl_3$. Buschow, K. H. J.; van Daal, H. J. (Philips Research Labs., Eindhoven, Netherlands). Solid State Commun.; 8: 363-5(Mar 1970).

The electrical resistivity of the compound $CeAl_3$ between 1.3 and 280°K has been observed to be markedly anomalous. Further information concerning the nature of this anomaly is presented here from data on the resistivity of compounds $Ce_{1-x}R_xAl_3$, R denoting La or Th. (auth) (UK)

24144 RADIATIVE DECAY OF ELECTRON-INDUCED SURFACE PLASMONS. Dobberstein, P.; Sauerbrey, G. (Physikalisch-Technische Bundesanstalt, Berlin). Phys. Lett.; 31A: 328-9(23 Mar 1970).

Discrimination between long-wave bremsstrahlung and radiative surface plasmon decay (Ag targets) was possible due to different dependencies of the radiation intensity I on electron energy E. The observed I(E) dependence may be explained if only small-wave-vector surface plasmons are allowed to radiate. (auth)

24145 ROTATIONAL HYSTERESIS OF THE ALLOYS OF $SmCo_5$-$SmCu_5$ SYSTEM. Uehara, Mitsuru; Morimoto, Ichiro (National Research Inst. for Metals, Tokyo). Jap. J. Appl. Phys.; 9: 226(Feb 1970).

Magnetic torque and rotational hysteresis measurements were carried out on $SmCo_{3.5}Cu_{1.5}$ at 77 and 300°K, in fields up to 20 kOe. Large hysteresis was observed for high fields at 77°K, and the annealing temperature was found to exert an effect. (D.L.C.)

24146 THERMOELECTRIC POWERS OF TRANSITION METALS AT HIGH TEMPERATURES. Vedernikov, M. V. (Inst. for Semiconductors, Leningrad). Advan. Phys.; 18: 337-70 (Jul 1969).

A survey and a discussion are presented of experimental data on the thermoelectric power (TEP) of transition metals. For the first time a critical review of the main data, which are given in the literature and proved to be rather incomplete, is presented. When necessary, the TEP measurements were conducted in the temperature range of 80 to 1800°K, wherever it was possible. TEP data were obtained for scandium, osmium, and hafnium; erroneous data for thorium and ruthenium were corrected; and the temperature range for many other metals was substantially extended. Finally, from the data found in the literature and the new results, a fairly complete notion has been formed of the high-temperature behaviour of TEP for all transition metals (except technetium) in the 3d, 4d, and 5d series of the periodic system, as well as for uranium and thorium. Some empirical regularities in the behaviour of TEP have been detected, the main one of which is that the TEP's of transition metals, which belong to a given column of the periodic table and are in a magnetically disordered state, vary with the temperature above 80°K in a similar way. It is shown that the TEP of transition metals is characterized by a complex, nonlinear temperature dependence. Consequently, the value and sign of the TEP at room temperature cannot serve as a sufficient criterion for characterizing the TEP. The general shape of the TEP temperature curve should be used as the criterion. (auth) (UK)

24147 PRESSURE DEPENDENCE OF MAGNETIC PHASE TRANSITIONS. Alfieri, Gaetano T. Brooklyn; Polytechnic Inst. of Brooklyn (1969). 92p.

Thesis.

The dominant interaction in rare-earth compounds with the CsCl structure is the RKKY exchange due to polarization of the conduction electrons. The ternary solid solutions $Gd(Zn_xAg_{1-x})$, $Gd(Zn_xIn_{1-x})$, $Gd(Zn_xCu_{1-x})$, and $(Gd_{1-x}Cd)_x(GdAg)_{1-x}[0 \le x \le 1]$ were prepared to study the effect of changes in the electron concentration on the magnetic properties of these materials. The Curie temperature of GdZn and $Gd_{1-x}Cd$ are about 280°K; the Néel temperatures of GdAg, GdCu, and GdIn are reported to be 145, 41, and 25°K. The change of the paramagnetic Curie temperatures in the $Gd(Zn_xAg_{1-x})$ and $Gd(Zn_xIn_{1-x})$ systems is in qualitative agreement with the $Gd(Ag_xIn_{1-x})$ systems as reported by Sekizawa, et al., and is consistent with theoretical expectations, assuming that Ag, Zn, and In give one, two, and three conduction electrons. The CsCl-type compounds of the heavy rare-earth metals with copper and those with silver are antiferromagnetic and those with zinc as well as TbHg are ferromagnetic. The isostructural compounds with cadmium which contribute the same number of conduction electrons as zinc and mercury may be expected to be ferromagnetic, especially for the heavy rare-earths. The magnetization of RCd (R = Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er or Yb) are measured between liquid helium and room temperature. The compounds are ferromagnetic except for PrCd, SmCd, and YbCd. PrCd may be antiferromagnetic; YbCd is paramagnetic. SmCd exhibits quite peculiar behavior: diamagnetic below 110°K and paramagnetic above. Anomalies are found in the thermomagnetic curves of ferromagnetic TbCd and DyCd, at 55°K and 40°K respectively. The paramagnetic moments per R, calculated from slope of 1/-T curves, are in general agreement with those for R^{3+}, except for the case of Yb. The RZn compounds (R = Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er) were prepared. Magnetization measurements showed that the heavy rare-earth compounds (Gd to Er) are ferromagnetic and the light rare-earth compounds, except SmZn, are paramagnetic and probably also antiferromagnetic. SmZn behaved like a ferromagnetic material with magnetic moment, 0.07 μ_B/Sm. The investigation of the effect of high pressures on the strength of the magnetic exchange interactions in ferromagnetic rare-earth compounds of zinc with the CsCl structure was performed in a "girdle" apparatus by a transformer method. The Curie point was detected by a change in the secondary voltage. The Curie temperature of GdZn decreased with increasing pressure at a rate of −0.3°K/kbar. For TbZn, dT_c/dp was approximately zero, while the Curie temperature of DyZn increased with increasing pressure, with dT_c/dp approximating +0.7°K/kbar. These results appeared to confirm the notion that the dependence of the exchange interaction on interatomic distance followed a "Heisenberg" type curve, with a maximum in the region of TbZn. This compound, and GdZn would be placed at the left side of the curve, while DyZn would be on the right side, where a decrease

in atomic spacing led to an increase in the strength of the ferromagnetic exchange interaction. The pseudobinary system $(Zr_{1-x}Nb_x)Fe_2$, with the cubic Laves structure, showed ferromagnetism for samples with $x \leq 0.45$. The lattice parameter decreased with increased Nb content; but, the major part of the change in T_c was not due to this decrease, as seen in the case of $(Zr_{1-x}Ti_x)Fe_2$. $Zr(Fe_{1-x}Co_x)_2$ behaves similarly. All of these samples showed a linear decrease of T_c with pressure. In the $(Zr,Nb)Fe_2$ series, $dT_c/dp = -3.3$°K/kbar for $x = 0.3$ and -3.5°K/kbar for $x = 0.35$. The permeability decreased with pressure, and the permeability-temperature curves behaved as if the compounds became paramagnetic when the temperature fell below 230°K. This temperature was the Curie temperature (at 1 atm) of $(Zr_{0.6}Nb_{0.4})Fe_2$ which was the limiting composition of the ferromagnetic region. $Zr(Fe_{1-x}Co_x)_2$ behaved similarly to $(Zr_{0.6}Nb_{0.4})Fe_2$ with $dT_c/dp = -4.7$°K/kbar for $x = 0.35$ and -6.6°K/kbar for $x = 0.4$. (Diss. Abstr.)

24148 PROCEEDINGS OF THE FIFTEENTH ANNUAL CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS, 18–21 NOVEMBER 1969 AT PHILADELPHIA, PENNSYLVANIA. J. Appl. Phys.; 41: 847-1438(1 Mar 1970). (CONF-691103).

The 219 papers (along with 47 abstracts and 2 titles) cover the following topics: nuclear antiferromagnetism in Ni–Cu alloys, anisotropic exchange, transition metal alloys, magnetic semiconductors, magnon pair modes, rare earth compounds, exchange enhancement, resonance, spin structures, insulators, monopoles, dilute alloys, surface modes, soft and hard magnetic materials, permanent magnets, Kondo effect, domains, ferrites and garnets, itinerant ferromagnetism, optical properties, thin films, critical phenomena, phase transitions, hyperfine fields, microwave and magneto-optical materials and devices, spin dynamics, magnetoelastic effects, and transport properties. Separate abstracts were prepared for 27 of the papers. (D.L.C.)

For abstracts of individual papers see: 23909, 24149–24168, and 24180–24185.

24149 EXPERIMENTAL EVIDENCE FOR ANISOTROPIC INTERACTIONS IN SOME RARE-EARTH INTERMETALLIC COMPOUNDS. Becle, Christian; Lemaire, Remy; Paccard, Dominique (CNRS, Grenoble, France. CENG, Grenoble, France). J. Appl. Phys.; 41: 855-63(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Magnetic properties were studied of the rare-earth alloys RAl, RNi, and R_3Ni, with R = Ce, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, in high magnetic fields up to 70 kOe. For the three series, the magnetic properties differ according to the alloyed rare earth. The compounds RAl of DyAl type and RNi of FeB type are ferromagnetic or antiferromagnetic. The compounds R_3Ni exhibit metamagnetism, except Tm_3Ni which has a ferromagnetic behavior. Magnetic structure of NdAl, TbAl, HoAl, ErAl, TmAl, NdNi, ErNi, HoNi, and Er_3Ni was studied by neutron diffraction. They have a noncolinear magnetic structure except NdNi, in which the magnetic moments are parallel. The stability of the magnetic structures was studied by means of group theory; they are all stabilized by strongly anisotropic magnetic interactions between rare-earth atoms. (auth)

24150 SPECTROSCOPIC DETERMINATION OF CRYSTAL-FIELD LEVELS OF Pr^{3+} IN THE PARAMAGNETIC METALLIC COMPOUND PrBi. Birgeneau, R. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Bucher, E.; Passell, L.; Price, D. L.; Turberfield, K. C. J. Appl. Phys.; 41: 900-1(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The $Pr^{3+}4f^2H_4$ manifold is split by an octahedral crystal field into four levels Γ_1, Γ_3, Γ_4, and Γ_5. Transitions between these levels in PrBi were measured using neutron time-of-flight spectrometry. Peaks in the observed spectra corresponding to crystal-field transitions are identified both by their temperature dependence and by comparison with corresponding data from (nonmagnetic) LaBi. Well-resolved crystal-field transitions are observed at 11.7 and 5.8 ± 0.6 MeV at 90°K. Additional scattering observed at room temperature is consistent with unresolved transitions at 7.6 and 4.1 MeV. As it is known from magnetic measurements that the Γ_1 singlet lies lowest, these four transitions may be identified as Γ_5 to Γ_4, Γ_4 to Γ_1, Γ_5 to Γ_3, and Γ_3 to Γ_4 respectively, thus accounting for all transitions allowed by magnetic-dipole selection rules. These data give the parameters $A_4^0\langle r^4\rangle = 6.89 \pm 0.30$ MeV and $A_6^0\langle r^6\rangle = 0.24 \pm 0.10$ MeV. (auth)

24151 INDIRECT EXCHANGE IN THE RARE-EARTH INTERMETALLICS. Levy, Peter M. (Yale Univ., New Haven). J. Appl. Phys.; 41: 902-4(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

There is no satisfactory fit to the ferromagnetic Curie points of the rare-earth intermetallic compounds having a Laves-phase structure using the Ruderman–Kittel–Kasuya–Yosida exchange interaction. By including a pair interaction of the form $L_A \cdot S_B$, the fit to the Curie points can be improved. This term enters when the effects of spin–orbit coupling of the conduction electrons on the indirect exchange interaction are included. (auth)

24152 PROPERTIES OF SmB_6 DOPED WITH Eu AND Gd. Geballe, T. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Menth, A.; Buehler, E.; Hull, G. W. J. Appl. Phys.; 41: 904-5 (1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

SmB_6 behaves as a nonmagnetic semiconductor at low temperatures; Gd- and Eu-doped samples were prepared. The paramagnetic behavior of the doped materials shows that Eu remains divalent and consequently it does not alter the low-temperature electrical properties appreciably. Gadolinium, on the other hand, increases the electrical conductivity and the paramagnetic behavior corresponds to the trivalent Gd ion. The paramagnetic susceptibility flattens out below 0.1°K, indicating a magnetic ordering of the Eu samples in contrast to the pure SmB_6. (auth)

24153 LONG-RANGE MAGNETIC INTERACTIONS IN URANIUM MONOPNICTIDES AND MONOCHALCOGENIDES AND THEIR SOLID SOLUTIONS. Kuznietz, Moshe (Argonne National Lab., Ill.); Grunzweig-Genossar, J. J. Appl. Phys.; 41: 906-8 (1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Uranium monopnictides (Uv) and monochalcogenides (Uvi) and their solid solutions have a NaCl-type structure and are good conductors of electricity. Measurements of the magnetic properties of these compounds show that the magnetic interactions between the localized 5f-electrons are of long range. Such long-range interactions are responsible for the type-I antiferromagnetic structure of Uv compounds and the ferromagnetic structure of Uvi compounds, although these magnetic structures could be explained by molecular field theory. A neutron-diffraction study of the UP–US solid solutions revealed two new long-range magnetic structures at intermediate compositions, the type-IA (2+, 2–) antiferromagnetic structure (found also in UAs at low temperatures) and the antiphase (5+, 4–) ferrimagnetic structure. These structures are due to long-range RKKY-type interactions via the conduction electrons. Analogous structures are observed in the lanthanides (e.g., thulium) and their metallic compounds. As the weight of the anions present increases, the importance of superexchange interactions increases and affects the type of magnetic ordering. This effect is more pronounced in lanthanide monopnictides and europium monochalcogenides than in the Uv and Uvi compounds. (auth)

24154 MAGNETIC PROPERTIES AND STRUCTURE OF GdN AND $GdN_{1-x}O_x$. Gambino, R. J. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.); McGuire, T. R.; Alperin, H. A.; Pickart, S. J. J. Appl. Phys.; 41: 933-4(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

GdN is shown to be ferromagnetic but small amounts of oxygen ($GdN_{1-x}O_x$ with $x \approx 0.05$) cause paramagnetism and short-range antiferromagnetic order to set in. This is attributed to nearest-neighbor interactions having opposite sign. (auth)

24155 RESISTIVITY MINIMA IN Pd(Np) ALLOYS. Nellis, W. J.; Brodsky, M. B. (Argonne National Lab., Ill.). J. Appl. Phys.; 41: 1007-8(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The electrical resistivities of several Pd alloys with Np concentrations ranging from dilute amounts up to 13 at. % were measured from 1.6 to 300°K. For Np compositions below 7.5%, resistivity minima were observed. Magnetic susceptibility data on the alloys containing 2.5 to 13% Np indicate localized moments at high temperatures and spin compensation at low temperatures. The Kondo temperature of the dilute alloys is estimated to be of the order 10 to 100°K. (auth)

24156 RARE-EARTH-COMPOUND PERMANENT MAGNETS. Becker, J. J. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys.; 41: 1055-64(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Since the discovery of the extremely high magnetocrystalline anisotropy of YCo_5 in 1966, there has been rapidly increasing interest in the development of cobalt–rare-earth intermetallic compounds as permanent magnet materials. The observed coer-

cive forces are still only a small fraction of the anisotropy fields, and for some reason the coercive forces attainable with $SmCo_5$ are larger than in other isostructural compounds with comparable anisotropy fields. A number of experiments have shown that the coercive force is very closely related to and can be profoundly influenced by the nature of the particle surface. The processing of these materials into magnets can be approached in several different ways, with due regard to the problem of chemical stability. The long-range prospects of these materials may well be related to the improvement of the properties of compounds other than $SmCo_5$ by influencing the factors that control the magnetization reversal process. (auth)

24157 APPLICATION OF STONER THEORY TO FERROMAGNETIC $ZrZn_{2-x}$ ALLOYS. Knapp, G. S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 41: 1073-4 (1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The magnetic properties were studied of a series of ferromagnetic alloys of $ZrZn_{2-x}$, where x varies from 0.05 to 0.2. The Stoner theory of ferromagnetism was found to be consistent with the data taken below T_c for all samples. Above T_c, however, the susceptibilities obeyed Curie–Weiss laws, $\chi \propto [1 - (T/T_c)]^{-1}$, and not $\chi \propto [1 - (T^2/T_0^2)]^{-1}$, as expected from the Stoner theory. (auth)

24158 ELECTRON SPIN RESONANCE IN FERROMAGNETIC $Sc_{3+x}In$ ALLOYS. Dunifer, G. L.; Knapp, G. S.; Corenzwit, E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 41: 1075-6(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Ferromagnetic $Sc_{3+x}In$ shows a strong narrow peak in the total magnetization as a function of x, with ferromagnetism occurring at low temperatures for x in the range of 0.10–0.20. The ESR properties of thin polycrystalline plates were studied for several values of x lying both within and also outside the ferromagnetic region. Measurements were made at 12 and 18 GHz as a function of temperature. The temperature range extended from 1.3 to 50°K (several times the maximum Curie temperature, T_c, of 7°K). The g-value (corrected for demagnetization effects) is 2.02 ± 0.01 at 1.4°K and appears to decrease to approximately 1.99 at the highest observable temperatures. The minimum linewidth occurs at T_c and increases slightly at lower temperatures. For $T > T_c$, the line broadens rapidly with increasing temperatures. A comparison of the ESR linewidth with the reciprocal of the total magnetization as a function of temperature shows that even though both have the same qualitative type of behavior, the quantitative agreement is not as good as that predicted by the theory of exchange enhancement of spin lifetimes. Although one might normally expect a rather fast relaxation rate for the electrons of such an alloy, it appears that the small g-shift and a form of exchange enhancement are important for substantially increasing spin lifetimes and producing narrow lines at low temperatures. (auth)

24159 EXCHANGE ENHANCEMENT OF CONDUCTION ELECTRON SPIN LIFETIMES IN $ZrZn_{1.9}$. Walsh, W. M. Jr.; Knapp, G. S.; Rupp, L. W. Jr.; Schmidt, P. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 41: 1081-2(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The magnetic resonance originally observed by Ogawa in the ferromagnetic regime of $ZrZn_2$ powder was reinvestigated in thin plates of $ZrZn_{1.9}$ of maximal Curie temperature and magnetization, at several microwave frequencies and over a wide temperature range extending well into the paramagnetic region. A g-value of 1.98 ± 0.01 was found at all frequencies and temperatures when demagnetization effects are taken into account. Well above the Curie temperature, the resonance broadens rapidly and independently of frequency, following the Curie–Weiss behavior of the susceptibility. This width is attributed entirely to lifetime (spin–lattice) broadening as in the conduction electron spin resonance of normal metals but here subject to strong exchange enhancement. The deduced "uncoupled" relaxation time is crudely consistent with an estimated transport collision frequency and the degree of spin–orbit coupling indicated by the small g shift. Extrapolation of the relaxation mechanism into the ordered regime predicts a linewidth proportional to the observation frequency roughly as observed, though an additional orientation-dependent broadening contribution appears at the lowest temperatures. (auth)

24160 FURTHER MAGNETIC AND THERMAL STUDIES OF CAST RARE-EARTH PERMANENT MAGNETS. Nesbitt, E. A.; Chin, G. Y.; Gallagher, P. K.; Sherwood, R. C.; Wernick, J. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 41: 1107-9(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Studies were made of the effect of composition on the magnetic properties of arc-cast alloys in the vicinity of $Co_{3.5}CuFe_{0.5}Ce$. The residual induction varies from 4000 to 6400 G with intrinsic coercive force values from approximately 5000 to 12,000 Oe. The maximum energy product values range from about 4 to 10×10^6 G Oe, the higher values generally associated with alloys of lower copper content. Freezing points of these alloys were determined for the first time using differential thermal analysis. Solidification occurs over a range of temperatures; initial freezing point decreases from 1177°C for a low-copper alloy ($Co_{3.94}Cu_{0.5}Fe_{0.56}Ce$) to 1124°C for a high-copper alloy ($Co_{3.43}Cu_{1.0}Fe_{0.56}Ce$). Several additional peaks were observed in the cooling curves after the initial freezing had occurred. These peaks are tentatively attributed to additional phases which are likely in view of the complexity of the Co–Ce and Cu–Ce binaries. The precipitation reaction at 400°C which was previously observed by metallography was evidently too weak to be detected in the DTA analysis. Measurement of magnetization versus temperature indicated that Curie temperatures are generally above 700°C depending on composition and heat treatment. (auth)

24161 MAGNON INTERACTIONS IN TERBIUM. Nielsen, M. (A.E.K. Research Establishment, Risoe, Denmark); Moller, Bjerrum; Mackintosh, A. R. J. Appl. Phys.; 41: 1174-5(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Magnon energies and lifetimes were studied in Tb and Tb–10% Ho single crystals by inelastic neutron scattering. The lifetimes of magnons propagating in the c-direction were measured in the ferromagnetic phase of Tb and are found to decrease with increasing temperature and wavevector, probably principally due to magnon–magnon interactions. The interaction of magnons with phonons was also observed and the effect of Ho impurities on this interaction studied. In addition, excitations ascribed to local modes associated with the Ho ions were observed. The dependence of the indirect exchange interaction on temperature in the alloy gives information on the mechanisms responsible for the transition from the helical to ferromagnetic structures. The dependence of the magnon energies on magnetic field at low temperatures gives detailed information on the role of magnetoelastic effects in the magnetic anisotropy. It is found that the cylindrically symmetric magnetoelastic effect gives a large contribution to the $q = 0$ magnon energy, in accordance with the "frozen lattice" model, and that the hexagonal anisotropy is probably principally due to crystal field effects. (auth)

24162 SPIN-WAVE EXCITATIONS IN $Ho_{0.5}Er_{0.5}$. Holden, T. M.; Powell, B. M.; Stringfellow, M. W.; Woods, A. D. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Appl. Phys.; 41: 1176-7(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The propagation of spin waves in the conical and spiral magnetic phases of the alloy $Ho_{0.5}Er_{0.5}$ was studied by neutron inelastic scattering. The spin-wave energies are comparable with those observed in Ho and Er. The spin-wave dispersion curves at 4.2°K were analyzed in terms of the Fourier transformed exchange energy, $J(q) - J(0)$, and an effective anisotropy parameter. The linewidths and energies of certain spin-wave modes were studied as a function of temperature. As the temperature was raised the spin-wave energies decreased. The linewidth of the distribution at $Q = (0,0,2\pi/c)$ increased sharply on raising the temperature toward the cone-to-spiral transition. No broadening was observed for the mode of the same wave vector in Ho over the same temperature range. (auth)

24163 MAGNETIC ANISOTROPY EFFECTS ON THE HALL RESISTIVITY OF RARE-EARTH METALS. Cullen, James R. (Naval Ordnance Lab., Silver Spring, Md.); Rhyne, James J.; Mancini, Ferdinando. J. Appl. Phys.; 41: 1178-9(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Results are presented for the normal and anomalous Hall coefficients R_0 and R_s in the rare-earth metals Tb, Dy, Ho, and Er in the paramagnetic temperature range. Above T_N, the anomalous coefficients are essentially temperature-independent, indicating a dominant spin-disorder scattering mechanism. Measurements with H along ⟨0001⟩ gave a constant value of $R_0 = -3.6 \times 10^{-12}$ Ω-cm/G for all elements of the series; R_s, on the other hand, varied by more than a factor of 8. This variation cannot be explained on the basis of an isotropic theory of spin disorder. The coefficients for H applied in the basal plane showed changes in

sign of both R_6 and R_4 occurring between Dy and Ho and a marked decrease in magnitude of R_4 throughout the series. A model is developed to include the effects of the large magnetic anisotropy on the anomalous coefficient. The model includes the contribution from both intrinsic and extrinsic spin–orbit couplings. The magnetic anisotropy has a significant effect on R_4, and leads to better agreement with experiment. (auth)

24164 MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF Pr–Gd ALLOYS. Tissot, L.; Blaise, A. (CEN, Grenoble, Franch). J. Appl. Phys.; 41: 1180-2(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Various Pr–Gd alloys, covering the whole range of compositions, were studied by x-ray diffraction and static magnetic measurements. The magnetization measurements were made in fields extending to 26 kOe in the temperature range 2 to 500°K. For the Pr–Gd system, the following phase diagram was found with the corresponding magnetic properties: (1) a Pr-rich phase of double hexagonal structure which is paramagnetic down to 2°K and which follows the Curie–Weiss Law; (2) a Gd-rich phase of compact hexagonal structure which is ferromagnetic at low temperature; and (3) a phase based on the composition Pr_2Gd_5 of super hexagonal structure (analogous to the structure of Sm) which is antiferromagnetic at low temperature. Two alloys having compositions just either side of this superhexagonal phase were studied. Their crystallographic structures could not be determined with precision. Their magnetic behavior corresponds to that observed in ferrimagnets. The ferromagnetic Curie temperatures of these alloys are higher than those observed in $Gd_{93}Pr_7$, situated in the Gd-rich phase. (auth)

24165 SPECTROSCOPIC OBSERVATIONS OF ANTIFERROMAGNETIC ERBIUM OXIDE. Bloor, D.; Dean, J. R.; Stedman, G. E. (Queen Mary Coll., London). J. Appl. Phys.; 41: 1242-4(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The far-infrared and visible spectra of erbium oxide were observed above and below the transition to the antiferromagnetic state at 3.4°K. Absorptions due to electronic transitions between levels of the ground-state multiplet appear in the far-infrared spectrum; they are split into several components below the Néel temperature. This structure can be interpreted in terms of transitions for ions on two inequivalent sites. The changes in the visible absorption spectrum, together with changes in phonon frequencies, are attributed to the presence of the exchange fields and a magnetostrictive expansion of the crystal lattice in the ordered state. This data and the results of crystal field calculations using the superposition model indicate a small value for g_z for C_2 site ions. Electron spin resonance spectroscopy and other methods give a much larger value for g_z. This discrepancy has not yet been resolved. (auth)

24166 RELATIONSHIP BETWEEN STOICHIOMETRY AND PROPERTIES OF EuO FILMS. Ahn, K. Y.; Shafer, M. W. (IBM T. J. Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 41: 1260-2(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The preparation of EuO films by co-evaporation of Eu and Eu_2O_3 was studied. The two most important parameters to control are the ratio $r = Eu/Eu_2O_3$ and the background pressure. The latter should be in the 10^{-4}-torr range, and only by starting with high density (>95%) Eu_2O_3 is it possible to maintain this. As r increases from 0.8 to 1.4: (1) A large increase in T_c is observed from 51 to 117°K; (2) the absorption a increases from 0.85×10^5/cm to 1.6×10^5/cm and the peak shifts toward the red (from 5900 to 6000 Å); (3) the longitudinal Faraday rotation 2ϕ (with 25° incident angle at 6328 Å) increases from 0.9×10^5 deg/cm to a maximum of 3.7×10^5 deg/cm, followed by a slight decrease; and (4) H_c (10°K) decreases sharply from 140 Oe to a minimum of 43 Oe for r = 0.94, followed by a slight increase. The best films which were single-phase stoichiometric EuO, with bulk-like properties, are obtained with r = 0.94. These have well-defined x-ray diffraction patterns with lattice constants $a_0 = 5.14$ Å, T_c of 71°K, and the normal Faraday rotation (at 20°K with H = 20 kOe) of 8.5×10^5 deg/cm. In films with r > 0.9 the increase of T_c is attributed to the presence of Eu metal which contributes conduction electrons to enhance the Eu^{2+}–Eu^{3+} interaction. For r < 0.9, films with $a_0 = 5.10$ are obtained which have $T_c = 51$°K. A model is proposed where the Eu^{2+}–Eu^{3+} exchange interaction is weakened by the formation of a metastable solution of Eu^{3+} in the EuO lattice. (auth)

24167 CRITICAL SCATTERING OF NEUTRONS FROM $RbMnF_3$. Lau, H.-Y.; Corliss, L. M.; Delapalme, A.; Hastings, J. M.; Nathans, R.; Tucciarone, A. (Brookhaven National Lab., Upton, N. Y.). J. Appl. Phys.; 41: 1384-9(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Measurements of the inelastic magnetic scattering of neutrons from $RbMnF_3$ in the vicinity of the critical point are presented and compared with the predictions of the dynamic-scaling proposal of Halperin and Hohenberg. At the Néel point, the energy dependence of the scattering for various wavevectors q is well represented by a universal three-peaked function in which the component widths and separations are all proportional to $q^{1.44 \pm 0.2}$, in excellent agreement with the concept of scaling as well as with the specific prediction of an exponent of 1.5. In the hydrodynamic region above T_N (q small compared to the inverse-range parameter, κ) the scattering is Lorentzian in energy. The half-width at q = 0 is proportional to $\kappa^{1.44 \pm 0.2}$, once again in good agreement with the scaling prediction. Over a broad region of the q, κ plane ($T \geq T_N$), where resolution corrections can be omitted, the "half-area" energy widths can be represented by a simple homogeneous function of q and κ, confirming the basic assumption of dynamic scaling. (auth)

24168 SPIN SCATTERING AND MAGNETIC ORDERING IN EuB_6. Bachmann, R. (Stanford Univ., Calif.); Lee, K. N.; Geballe, T. H.; Menth, A. J. Appl. Phys.; 41: 1431-2(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Magnetic and transport measurements in ferromagnetic EuB_6 show (a) evidence for a Fisher–Langer-type resistance anomaly near T_c, (b) that EuB_6 may not be a simple ferromagnet, and (c) that the magnetic coupling might be influenced by a temperature-dependent conduction electron concentration. (auth)

24169 SEMICONDUCTORS AND SEMIMETALS. VOLUME 4. PHYSICS OF III–V COMPOUNDS. Willardson, R. K.; Beer, Albert C. (eds.). New York; Academic Press Inc. (1968). 520p. $22.00.

The eight chapters on III–V compounds deal respectively with hardness, thermodynamics, diffusion, charge multiplication phenomena, pressure effects, radiation effects, solid solutions, and electric properties of nonuniform crystals. A separate abstract was prepared for the chapter on radiation effects. (D.L.C.)

For an abstract of one chapter see: 24132.

24170 ISOTOPE EFFECT IN THE PARAELASTIC RELAXATION. Pfister, G.; Kaenzig, W. (Eidgenoessische Technische Hochschule, Zurich). Phys. Kondens. Mater.; 10: 231-64(22 Dec 1969). (In German).

The kinetics of the reorientation of the molecular impurities $^{16}O_2^-$ and $^{18}O_2^-$ in the host lattices KCl, KBr, and KI have been investigated by means of ESR as a function of uniaxial stress in the temperature range between 1.3°K and 4.5°K. Below 4°K, the reorientation rate is proportional to the temperature, indicating that one-phonon processes dominate at low temperatures. For T > 4°K, the reorientation through excited librational levels becomes significant. The large isotope effect in the reorientation rate of $^{16}O_2^-$ and $^{18}O_2^-$ confirms that tunneling plays an important role. The analogy between the diffusion of polarons and the reorientation of molecules in solids is discussed in detail. The evaluation and interpretation of the experimental results in terms of the theory of Gosar and Pirc yields values for the tunneling matrix elements, the potential barrier between two equilibrium orientations, the libration frequencies, and an effective moment of inertia. The theory accounts well for the contribution of the one-phonon processes to the relaxation rate for stress along [001]. For stress along [111] the agreement is only qualitative. (auth)

24171 APPLIED SOLID STATE SCIENCE. Wolfe, Raymond; Kriessman, C. J. (eds.). Advances in Materials and Device Research. Volume 1. New York; Academic Press Inc. (1969). 413p. $15.00.

Four comprehensive reviews are included in this book, covering respectively: junction electroluminescence, metal–insulator–semiconductor physics, ion implantation in semiconductors, and electron transport through insulating thin films. A separate abstract was prepared for the review on ion implantation. (D.L.C.)

For an abstract of one paper see: 24133.

24172 ELECTRON SPIN RESONANCE IN Ti-DOPED VO_2. Goto, Tsuneaki; Nishimura, Katsuyuki; Kabashima, Shigeharu; Kawakubo, Tatsuyuki (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 28: 993-6(Apr 1970).

The behavior of carriers trapped around dopant Ti ions in VO_2 is investigated by means of ESR at 77 to 300°K. The line shapes are examined for different concentrations of Ti. At lower concentrations well-resolved hyperfine lines are observed and a broad background line is superposed on them. With increasing impurity concentration, however, the single broad line grows up and the hfs lines diminish. At the higher concentrations, only a single broad line of the Lorentz type is observed. The temperature dependences of the linewidth and the intensity for the hfs and broad lines are measured. The width of the broad line, constant at low temperature, starts to increase at a temperature above which the intensity deviates from the Curie law. The motion of carriers localized around Ti impurity centers is discussed. (auth)

24173 HARDNESSES OF CARBIDES AND OTHER REFRACTORY HARD METALS. Gilman, J. J. (Allied Chemical Corp., Morristown, N. J.). J. Appl. Phys.; 41: 1664-6(15 Mar 1970).

In a carbide or biboride the excess binding energy associated with metal–metalloid interactions must be overcome for a dislocation to move through the crystal structure. This makes possible a simple calculation of the indentation hardness number in terms of the heat of formation and the molecular volume. Good agreement with measurements is found for twelve representative compounds. (auth)

24174 INFLUENCE OF ANNEALING ENVIRONMENTS ON THE PERMEABILITY OF 4-79 MOLYBDENUM PERMALLOY. Kehr, W. D. (International Business Machines Corp., Boulder, Colo.). J. Appl. Phys.; 41: 1857-8(15 Mar 1970).

The magnetic permeability response of molybdenum Permalloy (Fe–80.26% Ni–4.17% Mo) to annealing in hydrogen, argon, or vacuum (5×10^{-6} to 10^{-3} torr) was studied, using 1- to 40-mil-thick samples. The permeability-frequency response curve showed that, although the three annealing atmospheres gave quite similar permeabilities, hydrogen still gave the highest permeabilities. (D.L.C.)

24175 TEMPERATURE DEPENDENCE OF THE PERIODICITY OF THE MAGNETIC STRUCTURE OF THULIUM METAL. Brun, T. O.; Sinha, S. K.; Wakabayashi, N.; Lander, G. H.; Edwards, L. R.; Spedding, F. H. (Ames Lab., Iowa). Phys. Rev., B; 1: 1251-3(1 Feb 1970).

A neutron-diffraction investigation was made of the variation with temperature of the characteristic wave vector of the magnetic structure of thulium metal. It was found that this wave vector is slightly incommensurate with the lattice periodicity in the purely sinusoidal phase, increases with decreasing temperature, and locks into the seven-layer periodicity at 32°K, while the sine wave squares up symmetrically until a ferromagnetic component appears at 32°K, causing it to develop finally the antiphase structure found earlier by Koehler et al. (auth)

24176 THE DIRECTIONAL MAGNETIC PROPERTIES AND STRUCTURES IN THE $SmCo_5$–$SmCu_5$ SYSTEM ALLOYS. Kimura, Yasuo; Kamino, Kimiyuki (Mitsubishi Steel Mfg. Co., Ltd., Tokyo). J. Jap. Inst. Metals; 34: 94-101(Jan 1970). (In Japanese).

Directional magnetic properties are observed in $SmCo_5$–$SmCu_5$ system alloy, which was subjected to freezing in a direction normal to the cold surface of the copper hearth. The maximum energy product, $(BH)_{max}$, of 65 wt % $SmCo_5$–35 wt % $SmCu_5$ alloy is 5.78 MGOe in the as-cast state when the measurement is carried out in the direction perpendicular to the chill plane. By annealing at 300°C for 1 hr, $(BH)_{max}$ value increases to 7.73 MGOe with Br = 6450 G and $_BHc$ = 3400 Oe. The magnetic properties in the direction perpendicular to the chill plane are superior to the other directions and the chill plane shows weak texture, (0001). These alloys have the easy direction of magnetization, which is the c-axis of the hexagonal crystal as $SmCo_5$. The lattice constants of both a- and c-axes of the hexagonal crystal enlarge linearly with increasing copper content. The value of lattice constant ratio c/a is approximately 0.802 in all the alloys. The results of x-ray micro analysis suggest that the alloys of this system alloy have congruent points and miscibility gaps in solid solution on a quasi-binary diagram. (auth)

24177 EFFECT OF NIOBIUM ADDITIONS ON THE PROPERTIES OF NEW HIGH MAGNETIC PERMEABILITY ALLOYS NIMALLOY IN THE NICKEL AND MANGANESE SYSTEM. Masumoto, Hakaru; Murakami, Yuetsu; Hinai, Masakatsu (Research Inst. of Electric and Magnetic Alloys, Sendai). J. Jap. Inst. Metals; 34: 40-4(Jan 1970). (In Japanese).

Masumoto et al. previously discovered high permeability alloys near in composition to Ni_3Mn which have an optimum degree of order, and named them "Nimalloy." Much subsequent work has since been carried out so as to investigate the effects of various additive elements on the properties of nickel–manganese alloys; as a result, the highest initial permeability of 76,000 and the highest maximum permeability of 441,000 have been obtained in the Ni–Mn–Fe–Cr system. The data on niobium additions to nickel–manganese alloys show that the initial and maximum permeabilities of nickel–manganese alloys at first increase gradually and later rapidly reach their maxima, and then decrease gradually. The alloy consisting of 77.55% Ni, 19.52% Mn, and 2.93% Nb exhibits the highest initial permeability of 32,500 when cooled at a rate of 240°C/hr from 900°C and reheated at 440°C for 41 hr, and the highest maximum permeability of 151,000 when cooled at a rate of 240°C/hr from 900°C and reheated at 420°C for 80 hr. In the latter case, the alloy shows a coercive force of 0.0149 Oe and a magnetic hysteresis loss of 22.00 erg/cm³/cycle for the maximum magnetic induction of 5000 G, and an electrical resistivity of 50.4 μ Ω-cm at 20°C. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 23012 and 24573.

24178 DYNAMICAL EFFECTS IN RESONANCE SCATTERING OF γ RAYS BY NUCLEI IN SOLIDS. Bashkirov, Sh. Sh.; Sadykov, E. K. (Kazan State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 11: 2129-30(Mar 1970).

Translated from Fiz. Tverd. Tela; 11: 2640-2(Sep 1969).

Angular distribution differences in Moessbauer spectroscopy are considered. Probability amplitude equations are derived for the γ-ray scattering with and without a dynamic perturbation. The two probabilities differ by the factor $A/2\gamma$, where A is the transition probability and $\gamma = \Gamma/2h$. The case of scattering by ^{57}Fe nuclei is considered, and angular correlation equations are derived. It is shown that the dynamic effects become important when $A^{cc'} \sim 2\gamma$, which is the case for paramagnetic Fe^{2+} compounds. (D.L.C.)

24179 PERTURBING EFFECT OF TWO ROTATING FIELDS ON ANGULAR CORRELATIONS. Lewis, R. R. Jr. (Univ. of California, Berkeley). Phys. Rev.; 186: 352-4(10 Oct 1969).

The theory of NMR in perturbed angular correlations is extended to include the effects of two rotating magnetic fields, and their superposition to give an oscillatory field. If both radiations are parallel to the static field, the counter-rotating field gives a second-order shift of the resonance (Bloch–Siegert effect). For other directions, there is a first-order change in the line shape which depends on the azimuthal orientation of the counters. (auth)

24180 ELECTRONIC CONFIGURATION OF SmB_6. Cohen, R. L.; Eibschuetz, M.; West, K. W.; Buehler, E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 41: 898-9(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The unusual magnetic and electrical properties of the semiconductor SmB_6 have been closely investigated recently. Primarily from magnetic susceptibility measurements, it has been hypothesized that the Sm valence changes from 3+ ($4f^5, ^6H_{\frac{5}{2}}$) at high temperatures to 2+ ($4f^6, ^7F_0$) at low temperatures. The Moessbauer effect in ^{149}Sm was used to make a direct determination of the valence state by means of the "isomer shift," which measures the s-electron density at the Sm nucleus. This density changes with the 4f configuration because of Coulombic shielding effects. Unfortunately, the change between $4f^5$ and $4f^6$ is too small to resolve resonance lines from the two charge states. The observed isomer shift of −0.4 mm/sec lies approximately halfway between the values (∼−0.9 and ∼0. mm/sec^{-1} respectively) obtained for well characterized ionic di- and trivalent Sm compounds, and is not observed to vary between room temperature and 1.1°K. A new model is presented to explain both the magnetic susceptibility data and the Moessbauer results. (auth)

24181 MOESSBAUER STUDY OF SOME 2-17 LANTHANIDE–IRON COMPOUNDS. Levinson, Lionel M. (Weizmann Inst. of Science, Rehovoth, Israel); Rosenberg, E.; Shaulov, A.; Shtrikman, S.; Strnat, K. J. Appl. Phys.; 41: 910-12(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The iron-rich, rare-earth–iron intermetallic compounds R_2Fe_{17} (R = Pr, Gd, Tm, Lu) were studied using the Moessbauer effect in ^{57}Fe. The measured average hyperfine field $H(T/T_c)$ acting on the ^{57}Fe nuclei is a unique, monotonically decreasing function of T/T_c, with no observed irregularity at temperatures corresponding to a suspected ferromagnetic–antiferromagnetic phase transition in these compounds. The onset of paramagnetism occurs at temperatures close to the upper transition points measured by Strnat et al., namely at T_c = 282, 472, 271, and 263°K for

Pr_2Fe_{17}, Gd_2Fe_{17}, Tm_2Fe_{17}, and Lu_2Fe_{17}, respectively. Low-temperature (≈90°K) spectra indicate the presence of at least four magnetically nonequivalent Fe sublattices, while for $T > T_c$ broadened 2-line absorption spectra typical of ^{57}Fe at noncubic sites in paramagnetic material are observed. (auth)

24182 LOCAL MOMENT FORMATION IN DILUTE ALLOYS. Brog, K. C.; Jones, Wm. H. Jr. (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys.; 41: 1003-6(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

^{59}Co NMR measurements in a series of alloys consisting of 0.3 to 1.2 at. % Co dissolved in Ti_xMo_{1-x} and Nb_xMo_{1-x} hosts, where $0 \leq x \leq 0.4$, were used to demonstrate that the continuous decrease in the average moment on the Co impurities with increasing Ti (Nb) concentration in the host does not result from a continuous decrease in the moment value of each Co ion but rather is due to an increasing number of Co ions which discontinuously become nonmagnetic. These results provide the first direct evidence for the applicability of the Jaccarino–Walker concept of discontinuous moment formation depending upon the local environment of the impurity. They clearly demonstrate that the qualitative explanation for the systematic variation in the average moment on iron-group impurities dissolved in the 4d transition series based on the U/Δ condition of the Anderson model and the average density of states of the host is inadequate for these alloys. (auth)

24183 RELATION BETWEEN NMR PROPERTIES OF ^{31}P IN THE PARAMAGNETIC STATE OF THE $UP_{1-x}S_x$ SYSTEM AND THE MAGNETIC ORDERING. Kuznietz, Moshe (Argonne National Lab., Ill.); Baskin, Yehuda; Matzkanin, G. A. J. Appl. Phys.; 41: 1111-13(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The UP–US solid solutions have a NaCl-type structure, are good conductors of electricity, and show systematic changes in the paramagnetic Curie temperature θ and the magnetic ordering (from antiferromagnetic type-I in UP to ferromagnetic in US). These changes are accounted for by RKKY-type interactions. NMR measurements, made on ^{31}P in the paramagnetic state of the $UP_{1-x}S_x$ system, are related to the magnetic ordering. There is good consistency between the NMR linewidths and the free induction (Bloch) decay-time constants, and between the echo decay-time constants and the calculated internuclear dipolar linewidths. The Knight shift K is linear in the susceptibility with a slope of (4.0 ± 0.5) (mole/emu), that is independent of x, and does not reflect the changes in θ and magnetic ordering, thereby disqualifying the simple RKKY model for K. The spin-lattice relaxation time T_1 increases with temperature T for all compositions, regardless of the magnetic ordering. T_1T is empirically related to K differently in the antiferromagnetic and ferromagnetic compositions. The T_1 results are discussed in terms of recently proposed models for nuclear relaxation due to indirect interactions with the localized magnetic moments via the conduction electrons. (auth)

24184 MAGNETIC AND STRUCTURAL PROPERTIES OF SOME RARE-EARTH–Sn_3 COMPOUNDS. Shenoy, G. K. (Argonne National Lab., Ill.); Dunlap, B. D.; Kalvius, G. M.; Toxen, A. M.; Gambino, R. J. J. Appl. Phys.; 41: 1317-18(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

The 23.8-keV Moessbauer resonance of ^{119}Sn and susceptibility measurements were used to study the structural and magnetic properties of $CeSn_3$, $PrSn_3$, and $NdSn_3$ intermetallic compounds between 293 and 1.6°K. The deterioration of the powder samples, which yields free tin and has led to inconsistent results in the past, is clearly demonstrated in these spectra. Both $PrSn_3$ and $NdSn_3$ exhibit magnetic hyperfine (hf) spectra below their Néel temperatures of 8.6 and 4.7°K, respectively. In $PrSn_3$, one-third of the Sn nuclei experience a transferred hf field of 67 kOe with the spin direction parallel to the principal electric-field-gradient axis, while the remaining Sn nuclei display no magnetic splitting. This is interpreted as the result of antiferromagnetic ordering of the first kind. In $NdSn_3$, the magnetic ordering appears to be more complex. In $CeSn_3$, neither magnetic ordering nor the "incipient ferromagnetism" previously suggested is seen. The size of the quadrupole interaction and the isomer shift are nearly equal in all these compounds. (auth)

24185 MOESSBAUER MEASUREMENTS IN EUROPIUM–CALCIUM AND EUROPIUM–STRONTIUM ALLOYS. Crecelius, G.; Huefner, S. (Freie Univ., Berlin). J. Appl. Phys.; 41: 1339-90(1 Mar 1970).

From 15th Annual Conference on Magnetism and Magnetic Materials, Philadelphia, Pa. See CONF-691103.

Moessbauer effect measurements were performed for Eu_xCa_{1-x} and Eu_xSr_{1-x} ($0 \leq x \leq 1$) alloys using the 22-keV γ-line in ^{151}Eu. The hyperfine (hf) fields extrapolated to zero europium content are –110 kOe for the EuCa system and –140 kOe for the CuSr system as compared to –150 kOe for the EuBa and EuYb system. On the other hand, the charge density at the Eu nucleus decreases only slightly in going from the EuYb to the EuCa system. The explanation of these hf-field measurements as well as g-shift measurements requires a varying d-electron contribution to the conduction band. (auth)

24186 OBSERVATION OF THE INTERFERENCE OF PHOTO EFFECT AND NUCLEAR RESONANCE ABSORPTION FOR MOESSBAUER E1 GAMMA RAYS. Henning, W.; Baehre, G.; Kienle, P. (Technische Hochschule, Munich). Phys. Lett.: 31B: 203-5(16 Feb 1970).

The interference of photoeffect and nuclear resonance absorption was observed in Moessbauer measurements for the following E1 γ transitions: 25.6 keV and 74.5 keV in ^{161}Dy, 86.5 keV and 105.3 keV in ^{155}Gd, and 97.4 keV in ^{153}Eu. The amplitude of the interference term is deduced and compared with the theory. (auth)

24187 MAGNETIC RESONANCE AND RADIOFREQUENCY SPECTROSCOPY. Proceedings of the XVth Ampere Conference, Grenoble, France, September 1968. Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Company (1969). 548p. $22.50. (In French and English). (CONF-680901).

Seventy-five papers and round-table discussions are presented under the following headings: invited papers; NMR in fluids; EPR in solids; paramagnetic, paraelectric, and color centers; magnetic resonance in metals; NMR in nonmetallic solids; rf spectroscopy of gases; electron spin relaxation and dynamic polarization; and magnetic resonance in ferromagnets. Separate abstracts have been prepared for six of the papers. (D.L.C.)

For abstracts of individual papers see: 22721, 23938, 24136, 24188, 24189, and 24199.

24188 DETECTION OF NMR BY NUCLEAR RADIATION. Shirley, D. A. (Univ. of California, Berkeley). pp 81-101 of Magnetic Resonance and Radiofrequency Spectroscopy. /Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From 15th Ampere Colloquium, Grenoble, France. See CONF-680901.

A summary is presented of some important features of radiative detection of NMR (NMR/RD). NMR/RD is contrasted with conventional NMR. A theoretical description of NMR/RD is given. Finally, experimental results are discussed. 29 references. (D.L.C.)

24189 EXCHANGE INTERACTIONS IN RARE-EARTH INTERMETALLIC COMPOUNDS AS DERIVED FROM KNIGHT SHIFT MEASUREMENTS. Van Diepen, A. M. (Univ., Amsterdam); De Wijn, H. W.; Buschow, K. H. J. pp 364-7 of Magnetic Resonance and Radiofrequency Spectroscopy. /Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From 15th Ampere Colloquium, Grenoble, France. See CONF-680901.

The Knight shifts in various series of rare-earth intermetallic compounds, such as RAl, RAl_2, RAl_3, and RCu (R = rare earth) were determined as a function of temperature. On the basis of the Ruderman–Kittel–Kasuya–Yosida theory, it is possible to derive from these data and from the paramagnetic Curie temperatures the exchange constant $\Gamma = 2J(O)$ between the conduction electrons and the localized 4f electrons. Γ is found to be a continuous function of the Fermi wave vector k_F. At low values of k_F it turns out to be positive, but there is a sign reversal at $k_F \approx 1.4$ Å^{-1}. This observed behavior is consistent with contributions from negative effective exchange interactions resulting from interband mixing, as was calculated by Watson et al. (Phys. Rev., 139: A167(1965)). (auth)

Theoretical Physics

Refer also to abstract 23553.

24190 (AD-699176) ON THE DERIVATION OF THE BELL–HIROTA REPRESENTATION OF THE PARTITION FUNCTION FOR INTERACTING BOSONS. Jalickee, J. B.; Wiegel, F. W. (Northwestern Univ., Evanston, Ill. Dept. of Physics). 26 Nov 1969. Contract N00014-67-A-0356-0002. 12p. CFSTI.

A simple representation of the partition function for interacting bosons was derived by Bell and Hirota. They used methods of second quantization, and the equivalence between Matsubara averages and averages over Gaussian random functions. A derivation of this representation is given which entirely bypasses

the formalism of second quantization, and uses methods of functional calculus only. (auth)

24191 (JINR-P9-4909) ON THE PROBLEM OF THE ULTRA-RELATIVISTIC ELECTRON BUNCH RADIATION IN A CYLINDRICAL RESONATOR. Kuznetsov, A. B.; Rubin, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The formula for the energy of the radiation, excited inside a closed cylindrical resonator by a relativistic electron bunch passing through the resonator, is analyzed. It is shown that, within the ultrarelativistic limit, the increase of the initial energy of the bunch does not lead to the increase of the radiation energy. (auth)

24192 (NYO-3399-201) SOLUTION OF MULTI-ATOM RADIATION MODEL USING BARGMAN REALIZATION OF THE RADIATION FIELD. Mallory, William R. (Syracuse Univ., N. Y. Dept. of Physics). July 1969. 43p. (SU-1206-201). Dep. CFSTI.

A model for interacting single-mode electromagnetic radiation and matter consisting of N two-level particles is solved exactly, using a representation in which the creation and destruction operators for the field act by multiplication and differentiation, respectively. The model includes off-resonant interactions. Closed-form expressions can be given for some special cases. The solutions are transformed to the more familiar Fock and Schroedinger representations. Numerical results are given to indicate the behavior of the solutions. An equation for a generating function is derived that would give solutions of the (algebraic) matrix equation to which the problem has been reduced. (auth)

24193 (UCRL-Trans-1403) LONGITUDINAL INSTABILITIES IN CIRCULAR CHARGED BEAMS. PART II. RADIATIVE INSTABILITY. Bonch-Osmolovskii, A. S.; Perel'shtein, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by T. Watt for Univ. of California, Lawrence Radiation Lab., Berkeley, from report JINR-P9-4425. 12p. Dep. CFSTI.

Impedances in the resonance case were calculated. Radiative energy losses are then calculated. (M.O.W.)

24194 CHARGE MOVING WITH THE SPEED OF LIGHT. Bonnor, W. B. (Queen Elizabeth Coll., London). Nature (London); 225: 932(7 Mar 1970).

The author has shown that Maxwell's equations admit solutions for a charge moving in a straight line with the speed of light (c). The accompanying electromagnetic field is that of a plane-fronted wave, that is, a wave whose front is plane and whose amplitude varies over the front. The source is a null four-current, J^i, satisfying $g_{ik}J^iJ^k = 0$, where g_{ik} is the metric tensor of flat space-time. The charge is localised in a world-tube about the Z axis of coordinates; all appropriate conditions are satisfied at the boundary of the tube and the F_{ik} are everywhere continuous. Although charge is radiated away from the source, conservation of charge is automatically ensured by Maxwell's equations. The solutions have precise analogues in Einstein-Maxwell theory. These solutions are perhaps not entirely conclusive, since the streams of charge originate at infinity. It is pointed out that solutions exist for null currents emitted from a point. The charge is accompanied by the field energy, also travelling radially with the speed of light, and both charge and energy automatically satisfy the usual conservation laws. The charge moves freely and no external force is necessary to maintain the current. Charged particles moving with speed c have not yet been identified in closed chambers, and the idea that charge, like energy, might be radiated through empty space is perhaps somewhat revolutionary. It is nevertheless clearly permitted by Maxwell's equations. It is suggested that experiments be carried out to look for the phenomenon. The theory does not indicate how to generate a null current, but possibly such a current might arise when a suitable pulse of light is generated at a charged source. (UK)

24195 COHERENCE AND NONLINEAR SCATTERING OF RADIATION. Prakash, H.; Chandra, N. (Univ. of Allahabad, India). Phys. Lett.; 31A: 331-2(23 Mar 1970).

Role of coherence in second harmonic generation in Compton scattering is studied and it is shown that some results reported in literature for plane polarized radiation hold for coherent radiation and that some other results reported for the case of unpolarized radiation are not correct. (auth)

24196 QUANTISATION OF WHEELER-FEYNMAN ELECTRODYNAMICS. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Nature (London); 225: 1233-4(28 Mar 1970).

Reference is made to Katz et al. (Nature 225: 534(1970)) who argued that the present author's treatment of spontaneous emission (Ann. Phys. 54: 207(1969)) deviates from the classical Wheeler-Feynman prescription. The argument was based on the form of the interaction term and would have been corrected for a two-particle system, but not for the system considered. The connection between the quantum and classical versions of the theory of direct interparticle action is discussed. The interference of probability amplitudes in the quantum theory leads to results that have no analogues in the classical theory, but when $h \to 0$ the quantum theory must lead to the classical theory. The classical WF radiation reaction formula follows from the quantum calculations in the limit $h \to 0$. (UK)

24197 OBSERVATION PROBLEM IN QUANTUM MECHANICS. Jasselette, P. (Univ., Liege); Voisin, J. Nuovo Cim.; 66B: 229-38(11 Apr 1970). (In French).

A critical review of the different interpretations of the observation process in quantum mechanics is presented. (auth)

24198 FREE FALL OF A CLASSICAL CHARGED PARTICLE. Luiz, A. M. (Univ., Pisa, Italy). Lett. Nuovo Cim.; 3: 180-1 (5 Feb 1970).

It is generally accepted that a neutral and a charged particle fall equally fast in a static homogeneous gravitational field (SHGF). This is valid for point particles, because point charges have no self-interaction; however, the authors in this note show that for extended charges this is not always true. The case of low velocity is considered, and it is found that in a SHGF the charged particles fall with an acceleration that lies between the limits of g and g/2. (TSS)

24199 TESTS OF QUANTUM ELECTRODYNAMICS FROM RADIOFREQUENCY STUDIES OF ATOMS. Hughes, Vernon W. (Yale Univ., New Haven). pp 1-22 of Magnetic Resonance and Radiofrequency Spectroscopy. /Averbuch, P. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From 15th Ampere Colloquium, Grenoble, France. See CONF-680901.

Reasons for further tests of the validity of quantum electrodynamics are outlined. Possible tests include these of the general invariances of symmetries of the theory, and specific dynamic tests of the theory. Lamb shift, fine structure constant α, electron and muon g-values, positronium, muonium, and helium fine structure are discussed. In all the experiments on the leptons and simple atoms, conventional quantum electrodynamics has survived all tests without any clear violation. 62 references. (D.L.C.)

24200 THE FORMULATION OF CONSTITUTIVE EQUATIONS IN CONTINUUM RELATIVISTIC PHYSICS. Lianis, G. (Purdue Univ., Lafayette, Ind.). Nuovo Cim.; 66B: 239-59(11 Apr 1970).

The restrictions in the form of constitutive functions of relativistic continuum physics resulting from the requirement of form invariance under the Lorentz group are examined. These functions are assumed to depend on the deformation gradient and a number of vectors. It is shown that the restricted forms are the relativistic extensions of similar expressions of classical continuum physics derived previously. (auth)

24201 STOCHASTIC PROCESSES IN CHEMICAL PHYSICS. Conference Held at San Diego, La Jolla, California, March 18-22, 1968. Shuler, K. E. (ed.). Advances in Chemical Physics, Volume XV. London; John Wiley and Sons (1969). 381p. £ 9.5.0d. (CONF-680331).

The twenty chapters are based on papers presented at the conference and are representative of some of the current work on the application of stochastic theory to a variety of problems in chemical physics. A separate abstract was prepared for the chapter dealing with neutron scattering by simple liquids. (UK)

For an abstract of one paper see: 24496.

24202 STIMULATED RADIATION FROM CHARGED PARTICLES MOVING IN A PLANE ELECTROMAGNETIC FIELD. Bagrov, V. G.; Khalilov, V. R. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 50-3(1969). (In Russian).

Charged particle motion in the field of a plane electromagnetic wave was studied. It is shown that during this particle irradiation by another electromagnetic wave, at a certain angle of incidence to the first, a process of stimulated radiation and absorption is observed. Moreover, at certain conditions, the stimulated radiation prevails over the absorption. The postulation is confirmed considering a scalar particle (boson) with a certain charge e moving in the field of a plane monochromatic circular polarized wave in motion along the z axis. (R.V.J.)

24203 NEW PERTURBATION METHOD FOR THE INTEGRALS OF MOTION OF TIME-DEPENDENT SYSTEMS. Lacina, J. (Inst. of Plasma Physics, Prague). Ann. Phys. (N. Y.); 57: 136-44(Mar 1970).

A solution of motion defined by a Hamiltonian function $\mathcal{H} =$

$\mathcal{H}_0(q_k, p_k) + \Sigma_{n=1} \lambda^n \mathcal{H}_n(q_k, p_k; t)$, k = 1, 2, . . . , N of a system in time-dependent fields, is found by the use of power series expansions in a perturbation parameter. The solution is in the form of 2N independent integrals of motion, the perturbation terms of the integrals being described by recursion formulas. The integrals of motion are canonically conjugate quantities. The method is also used to evaluate the distribution function as the general nonlinear solution of the Vlasov equation (in collisionless plasma kinetics, the distribution function as a solution of the Vlasov equation is an integral of motion). (auth)

24204 GENERALIZED SCHROEDINGER REPRESENTATIONS. III. Nodvik, John S. (Univ. of Southern California, Los Angeles). Ann. Phys. (N. Y.); 57: 145-73(Mar 1970).

The three-dimensional three-coordinate angular momentum problem is analyzed in terms of the formalism of generalized Schrödinger representations developed in two previous papers. It is shown that the three-coordinate problem may be factored in terms of two spinors. The classical and quantum formulations of the problem of the coupling of two three-coordinate angular momenta are given and simple solutions are obtained in terms of relations between angular momentum creation and annihilation operators. (auth)

24205 QUANTUM ZERO-POINT ENERGY AND LONG-RANGE FORCES. Boyer, Timothy H. (Univ. of Maryland, College Park). Ann. Phys. (N. Y.); 56: 474-503(Feb 1970).

The ideas of quantum zero-point energy may be used to evaluate forces arising in electromagnetism, nuclear physics, and pair theory. A review is presented of the calculations involving electromagnetic theory, where the forces are termed long-ranged van der Waals forces, or retarded dispersion forces. Experimental confirmation of the calculations is pointed out when possible. Inasmuch as long-range van der Waals forces have been evaluated by a number of quantum field-theoretic methods, there is an attempt made to understand the success of the zero-point energy calculations in the context of quantum field theory. There appears to be a close connection between the electromagnetic zero-point calculations and pair theory. It is noted that only in the case of electromagnetism are the forces arising from zero-point energy found to be cut-off independent. Heuristic connections between zero-point energy and semiclassical fluctuation phenomena are noted throughout the analysis. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

For abstracts of individual papers see 24224, 24236, 24237, 24265, 24334, and 24335.

24206 (ANL/HEP-6909) SYMPOSIUM ON MULTIPARTICLE PRODUCTION, DECEMBER 5-6, 1968. (Argonne National Lab., Ill.). 180p. (CONF-681206). Dep. CFSTI.

The conference included eight papers. Separate abstracts were prepared for seven papers. The text of the other paper on one-pion exchange in multiparticle production was not available. (J.F.P.)

24207 (ANL/HEP-6909, pp 3-36) MULTIPARTICLE PRODUCTION AT COSMIC RAY ENERGIES. Murthy, P. V. Ramana (Michigan Univ., Ann Arbor. Dept. of Physics).

A review is given of experiments on cosmic radiation with multiparticle production. The energy ranges below 10^{12} eV and ranges above this energy are covered. Also the isobar plus fireball model is described, and various interpretations of the experiment on the sec θ effect are given. (J.F.P.)

Electromagnetic

24208 NEUTRAL-BOSON PHOTOPRODUCTION ON HYDROGEN AT HIGH ENERGIES. Anderson, R. (Stanford Univ., Calif.); Gustavson, D.; Johnson, J.; Ritson, D.; Wilk, B. H.; Jones, W. G.; Kreinick, D.; Murphy, F.; Weinstein, R. Phys. Rev., D; 1: 27-47(1 Jan 1970).

Photoproduction cross sections for neutral π, η, ρ, and ϕ mesons were measured at the Stanford Linear Accelerator Center for photon energies between 5 and 17.8 GeV, and t (four-momentum transfer squared) between -0.12 and -1.4 $(GeV/c)^2$, using a missing-mass technique. The pion production at lower energies is characterized by a fast falloff with increasing $|t|$ at small $|t|$ values, with a dip at $t = -0.5$ $(GeV/c)^2$ followed by a secondary maximum around $t = -0.9$ $(GeV/c)^2$ and a smooth falloff at larger $|t|$ values. As the incident photon energy increases, the dip becomes less pronounced, in contradiction to the expectations of simple Regge theories based only on the exchange of the ω and B trajectories. η photoproduction was measured around 6 GeV and at 9 GeV. The cross section decreases smoothly with t and shows no dip at $t = -0.5$ $(GeV/c)^2$, in disagreement with predictions based on Reggeized ρ exchange. ρ production rates agree well with predictions assuming diffraction production. The differential cross section varies approximately as $e^{8.5t}$. The total cross section decreases from 16.0 μb at 5.5 GeV to 12.3 μb at 17.8 GeV incident photon energy. A quark-model relation between π-p elastic scattering and ρ photoproduction gives a good representation of the data. ϕ production also appears consistent with the predictions of the diffraction-dissociation model. A search was also made for evidence of photoproduction of other particles with mass up to 2 GeV. Production of one particle of mass 1240 ± 20 MeV and width around 100 MeV was observed. No particles with mass between 1300 and 2000 MeV were found. Any particle with cross section larger than 4% of the ρ cross section would have been visible. (auth)

24209 BACKGROUND EFFECTS IN THE SEARCH FOR QUARKS. Kiraly, P.; Wolfendale, A. W. (Univ. of Durham, Eng.). Phys. Lett.; 31B: 410-12(16 Mar 1970).

The problem of identifying quarks amongst cloud chamber tracks is examined and the expected numbers of conventional particles, simulating quarks, are derived for various conditions. (auth)

24210 SEARCH FOR THE DIRAC MONOPOLE AT THE 70 GeV I.P.H.E. PROTON SYNCHROTRON. Gurevich, I. I. (Kurchatov Inst. of Atomic Energy, Moscow); Khakimov, S. Kh.; Martemianov, V. P.; Mishakova, A. P.; Ogurtzov, V. V.; Tarasenkov, V. G.; Barkov, L. M.; Tarakanov, N. M. Phys. Lett.; 31B: 394-6(16 Mar 1970).

A search for the Dirac monopole at the 70 GeV I.P.H.E. proton synchrotron is described. It was found that the upper limit of the monopole production cross-section was $\sigma(90\%) \leq 1.5 \times 10^{-41}$ cm^2 for $m_q \leq 5m_p$. (auth)

24211 EXPERIMENTS WITH THE ORSAY STORAGE RING ACO. Perez-y-Jorba, J. (Ecole Normale Superieure, Orsay, France). pp 213-23 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th-20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

Results of some new experiments are described, together with new data from older experiments, under the following headings: $K^+ K^-$ decay of the ϕ (experimental set-up; analysis criteria; results); $\phi \rightarrow K_S^0 K_L^0$ and $\phi \rightarrow 3\pi$; 2π production and ω-p interference (phenomenonological analysis; results and conclusions); quantum electrodynamics (double bremsstrahlung luminosity measurement; QED test in Bhabha scattering; $\mu^+ \mu^-$ test of QED); beam polarisation; coupling constants and sum rules (coupling constants and mixing angles; sum rules); finite width effects and vacuum polarisation. (40 references) (UK)

24212 STORAGE RINGS: NOVOSIBIRSK. Sidorov, V. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 227-32 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th-20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

Some preliminary results of the ϕ-meson resonance study by electron-positron colliding beams are described, and a brief description is given of the state of progress of the installation of the electron-positron storage ring (VEPP3) for a maximum energy of 2 × 3.5 GeV. (15 references) (UK)

24213 SEARCH FOR T-INVARIANCE VIOLATION IN THE INELASTIC SCATTERING OF ELECTRONS FROM A POLARIZED PROTON TARGET. Rock, Stephen (Univ. of California, Berkeley); Borghini, Michel; Chamberlain, Owen; (and others). Phys. Rev. Lett.; 24: 748-53(30 Mar 1970).

An asymmetry is sought in the inelastic scattering of electrons from a polarized proton target in the region of resonance excitation, at values of four-momentum transfer squared of 0.4, 0.6, and 1.0 $(GeV/c)^2$. Data were also taken using an incident positron beam in order to distinguish any possible effect of time-reversal invariance violation from that due to higher-order (α^3) contributions to the scattering. No sizable violation of time-reversal invariance was found. (auth)

24214 MEASUREMENT OF THE POLARIZATION IN ELASTIC ELECTRON-PROTON SCATTERING. Powell, Thomas (Univ. of California, Berkeley); Borghini, Michel; Chamberlain, Owen; (and others). Phys. Rev. Lett.; 24: 753-6(30 Mar 1970).

The asymmetry in the elastic scattering of electrons from a polarized proton target was measured. An interference between the imaginary part of the two-photon-exchange amplitude and the one-photon-exchange amplitude could produce a polarization effect. The results indicate no asymmetry within the experimental accuracy of 1 to 2% at four-momentum-transfer-squared values of 0.38, 0.59, and 0.98 $(GeV/c)^2$. (auth)

24215 PHOTOPRODUCTION OF NEUTRAL RHO MESONS FROM COMPLEX NUCLEI. Alvensleben, H.; Becker, U.; Bertram, K.; (and others). (Deutsche Elektronen Synchrotron, Hamburg. Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 24: 786-92(6 Apr 1970).

Results of measurements on photoproduction of ρ mesons are presented. Analysis of 10^6 measured ρ events in a four-dimensional data matrix $d\sigma(A,m,p,t_\perp)/d\Omega dm$ with dimensions 14 × 20 × 10 × 20 yields precise information on nuclear density distributions for ρ production. The Woods-Saxon radii $R(A) = (1.12 \pm 0.02)A^{\frac{1}{3}}$ are obtained and, using the vector dominance model, $\sigma_{\rho N} = 26.7 \pm 2.0$ mb and $\gamma_\rho^2/4\pi = 0.57 \pm 0.10$ are obtained. (auth)

24216 COHERENT PHOTOPRODUCTION OF RHO MESONS. Knasel, T. M. (Massachusetts Inst. of Tech., Cambridge). pp 87-96 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

The results of DESY-MIT measurements of coherent ρ photoproduction on 14 elements, hydrogen through uranium, are presented and briefly discussed. The data, based on one million events, are organized in a four dimensional matrix where the dependency of the cross section of mass, on momentum, and on momentum transfer are all separate. The results, $\sigma_{\rho N} = 26 \pm 2$ mb and $\gamma_\rho^2/4\pi = 0.54 \pm 0.10$, confirm earlier DESY measurements; the difference found by Cornell and SLAC is attributed to analysis and normalization. (L.B.S.)

24217 INELASTIC ELECTRON-PROTON SCATTERING. Mo, L. W. (Stanford Linear Accelerator Center, Calif.). pp 127-

60 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Electron-proton elastic scattering data based mainly on experiments performed at SLAC by a SLAC-MIT collaboration are presented and discussed. The following topics are discussed: kinematics and cross section formula; SLAC-MIT experiment; cross section in the region of the nucleon resonances; results and comparison with theory; cross section in deep inelastic region; total photon-proton cross sections and axial form factors. 44 references. (L.B.S.)

24218 TOTAL CROSS-SECTIONS OF $\pi^+\pi^-$ AND $\pi^-\pi^0$ PHOTOPRODUCTION ON NEUTRON IN DEUTERIUM BUBBLE CHAMBER UP TO 900 MeV. Piazza, A. (CNEN, Frascati, Italy); Susinno, G.; Fiore, L.; Gialanella, G.; Lodi-Rizzini, E.; Mantovani, G. C.; Piazzoli, A.; Carbonara, F.; Palomba-Nicodemi, G.; Rinzivillo, R.: Lett. Nuovo Cim.; 3: 403-8(21 Mar 1970).

Preliminary results of an investigation of the interactions $\gamma + n \rightarrow p + \pi^- + \pi^0$, $\gamma + n \rightarrow n + \pi^+ + \pi^-$, and $\gamma + p \rightarrow p + \pi^+ + \pi^-$ in a deuterium bubble chamber exposed to a 1-GeV bremsstrahlung beam are reported. The analysis procedure is described, and the total cross sections are given. (J.F.P.)

24219 PASSAGE OF ELECTRONS THROUGH THICK LAYERS OF MATTER (ENERGY DISTRIBUTION). Gusev, E. A.; Kononov, B. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 12-15(1969). (In Russian).

Using a magnetic beta spectrometer, thorough investigations were made of the energy distribution of electrons, having an initial energy of 6.74 MeV, after passage through samples of C, Al, Cu, Sn, and Pb having thicknesses up to 0.5 R. (tr-auth)

24220 EXPERIMENTAL INVESTIGATIONS OF PHOTON–ELECTRON CONVERSION IN COPPER UPON THE PASSAGE OF HIGH-ENERGY BREMSSTRAHLUNG. Vorob'ev, V. A.; Vorob'ev, S. A.; Pushkin, A. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 128-30(1969). (In Russian).

One of the serious problems of investigations with bremsstrahlung is that of depth distribution of absorbed energy (DDAE). Up to the present time this problem was studied slightly, especially in the high-energy region. The DDAE curve for separate elements was only known for energies below 330 MeV. An investigation was conducted of the depth distribution of absorbed energy in copper for bremsstrahlung at 250 to 1000 MeV. The 1.5-GeV synchrotron at the Tomsk Polytechnic Institute was the radiation source. The investigation was made using the photographic method with x-ray film of types PT-1, PT-2, and PM-1. The bremsstrahlung beam, purified from electrons, fell on a block of absorber, which was assembled from the plates of the studied material and paper cassettes with x-ray film located at various depths. As a result of the great distance from the target (approximately 12m) and strong collimation (ϕ collimator 10 to 20 mm) the radiation field was even and the bremsstrahlung beam was approximately parallel. The DDAE curve in copper for bremsstrahlung at 1000 MeV is given. For low energies in the studied energy range for bremsstrahlung, the depth of absorber at which the absorbed-energy is observed, depends on the magnitude of the bremsstrahlung energy and equals 20, 23.7, 25, and 26.3 mm for bremsstrahlung energies of 250, 500, 700, and 1000 MeV respectively. As the investigations show the steepness of the first part of the curve decreased with the increase of bremsstrahlung energy. This is caused by the increase of secondary electron energy and range in proportion to the increase of bremsstrahlung energy. The increase of secondary-electron energy and related to it the decrease of secondary-particle scattering below 180° explains the initial decrease with the increase of bremsstrahlung energy. (tr-auth)

Weak

24221 EXPERIMENTAL LIMIT ON NEUTRINO–ELECTRON SCATTERING. Steiner, H. J. (Technische Hochschule, Aachen). Phys. Rev. Lett.; 24: 746-8(30 Mar 1970).

From an analysis of electron production in the CERN neutrino spark-chamber experiment, it is concluded that the cross section for neutrino-electron scattering is less than $40\sigma_{V-A}$ with 90% confidence. (auth)

24222 ASYMMETRY PARAMETER FOR $\Lambda^0 \rightarrow n\pi^0$. Olsen, S. (Univ. of Wisconsin, Madison); Pondrom, L.; Handler, R.; Limon, P.; Smith, J. A ; Overseth, O. E. Contract Nos. T(11-1)-881; NONR 1224 (23). Phys. Rev. Lett.; 24: 843-7(13 Apr 1970).

The asymmetry parameter α_0 for $\Lambda^0 \rightarrow n\pi^0$ was measured relative to α_- by comparing the neutron distribution with the proton distribution from the decay $\Lambda^0 \rightarrow p\pi^-$ for polarized Λ^0 hyperons. A sample of 4760 neutron decay events and 8500 proton decay events gave $\alpha_0/\alpha_- = 1.000 \pm 0.068$ in good agreement with the $|\Delta I| = 1/2$ rule. (auth)

24223 ANGULAR DEPENDENCE OF K_L–K_S REGENERATIVE SCATTERING FOR COPPER AND LEAD NUCLEI AT HIGH ENERGIES. Foeth, H. (Technische Hochschule, Aachen); Holder, M.; Radermacher, E.; (and others). Phys. Lett.; 31B: 544-8(13 Apr 1970).

Elastic and inelastic K_L–K_S regenerative scattering on copper and lead nuclei have been observed up to a momentum transfer of 0.17 GeV/c. The elastic differential cross section is of a "diffractive" type. It can be described successfully in terms of an optical model only assuming an appreciable neutron excess in the vicinity of the nuclear surface. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 24246, 24251, 24334, and 24374.

24224 (ANL/HEP–6909, pp 114-49) SINGLE PARTICLE DISTRIBUTIONS IN HIGH ENERGY COLLISIONS. Krisch, A. D. (Michigan Univ., Ann Arbor).

Some p + p experiments are discussed which ignore the correlations between particles in the final states. The production of many mesons is considered in these interactions. (J.F.P.)

24225 INTERPRETATION OF THE $p\pi^+\pi^-$ AND $\bar{p}\pi^+\pi^-$ MASS SPECTRA IN THE REACTION $\bar{p}p \rightarrow \bar{p}p\pi^+\pi^-$ AT 2.7 AND 2.9 GeV/c. Kernan, W. J.; Crawley, H. B.; Jespersen, R. A.; Leacock, R. A. (Ames Lab., Iowa). Phys. Rev., D; 1: 48-53(1 Jan 1970).

The reaction $\bar{p}p \rightarrow \bar{p}p\pi^+\pi^-$ was studied for $p\pi^+\pi^-$ and $\bar{p}\pi^+\pi^-$ enhancements using 719 events at 2.7 GeV/c and 1015 events at 2.9 GeV/c. It is found that the $p\pi^+\pi^-$ and $\bar{p}\pi^+\pi^-$ mass spectra can be adequately explained by assuming that the reaction proceeds 100% through the $\bar{\Delta}^{--}(1236)\Delta^{++}(1236)$ channel, and that it is not necessary to assume the production of $p\pi^+\pi^-$ or $\bar{p}\pi^+\pi^-$ resonances in this reaction at these energies. (auth)

24226 SPIN CORRELATION PARAMETER A_{xx} AND A_{yy} MEASUREMENTS IN p-p SCATTERING AT 37.2 MeV. Garreta, D. (Centre d'Etudes Nucleaires, Saclay, France); Nisimura, K.; Fruneau, M. Phys. Lett.; 31B: 363-4(16 Mar 1970).

The measurements of A_{xx} and A_{yy}, the spin correlation coefficients in proton-proton scattering made at Saclay in the lab energy range of 11 to 26 MeV were extended to 37 MeV with the same experimental techniques. Comparison of the results with the predictions of the energy dependent phase shift analysis of Livermore shows a very good agreement for A_{yy} but a significant deviation (≈2.4 standard deviations) for A_{xx}. (auth)

24227 MEASUREMENT OF THE POLARIZATION PARAMETER IN $\pi^\pm p$, $K^\pm p$, pp, AND $\bar{p}p$ ELASTIC SCATTERING AT 6 GeV/c. Borghini, M. (CERN, Geneva); Dick, L.; Di Lella, L.; (and others). Phys. Lett.; 31B: 405-9(16 Mar 1970).

Experimental results are presented for the polarization parameter P_0 in $\pi^\pm p$, $K^\pm p$, pp, and $\bar{p}p$ elastic scattering at 6 GeV/c, and in the range of the invariant four-momentum transfer squared-t from 0.05 to ~2.0 $(GeV/c)^2$. (auth)

24228 LOW-ENERGY ANTIPROTON–PROTON ELASTIC SCATTERING IN THE ENERGY RANGE FROM 10- TO 80-MeV INCIDENT KINETIC ENERGY. Goldberg, Robert. New Brunswick, N. J.; Rutgers-The State Univ. (1969). 95p.

Thesis.

Antiproton proton elastic and differential cross sections were measured in seven energy intervals from 10 to 80 MeV incident kinetic energy, using 7000 elastic scattering events from the Brookhaven 30" hydrogen bubble chamber. The low energy data indicate the existence of a destructive Coulomb interference in $d\sigma/d\Omega$. The data are found to be in good agreement with the calculations of Bryan and Phillips, except for a dip in the elastic cross section at 65 and 75 MeV. The probability that this dip represents a statistical deviation from a straight line fit to the low energy elastic cross section is less than one percent. (Disser. Abstr.)

24229 MODEL FOR PROTON–PROTON SCATTERING. Zipfel, G. G. Jr. (State Univ. of New York, Stony Brook). Phys. Rev. Lett.; 24: 756-8(30 Mar 1970).

A semiclassical model for inelastic and elastic proton–proton scattering is presented. A fit to recent π production counter data is made. The resulting proton–proton elastic scattering and proton electromagnetic form factor are discussed. Reasonable agreement with the data is obtained. (auth)

24230 STRONG-INTERACTION NUCLEAR RADII. Alvensleben, H.; Becker, U.; Bertram, William K.; (and others). (Deutsche

Elektronen Synchrotron, Hamburg. Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 24: 792-6(6 Apr 1970).

Results on the determination of a set of strong-interaction nuclear radii using the photoproduction of neutral rho mesons are presented. Analysis of 10^6 events from 13 complex nuclei yields the Woods-Saxon radii $R(A) = (1.12 \pm 0.02)A^{\frac{1}{3}}$ fm. (auth)

24231 EVIDENCE FOR Ξ RESONANCES IN THE Ξ(1530)π SYSTEM. Apsell, S. (Brandeis Univ., Waltham, Mass.); Barash-Schmidt, N.; Kirsch, L.; (and others). Phys. Rev. Lett.; 24: 777-81(6 Apr 1970).

Evidence is presented for the decay of Ξ(1820) and Ξ(1930) resonances to Ξ(1530)π, and for an $I = \frac{1}{2}$ assignment to these states. By combining data from the Ξπ and Ξ(1530)π decays of these resonances, we have determined their masses (1820 ± 7, 1963 ± 8) MeV, widths (64 ± 23, 89 ± 33) MeV, and branching ratios $[\Xi\pi/\Xi(1530)\pi = 1.5^{+1.0}_{-0.5}, 2.8^{+2.0}_{-1.0}]$. (auth)

24232 THRESHOLD ENHANCEMENTS IN $\rho^0\pi^-$ AND $f^0\pi^-$ SYSTEMS. FROM THE REACTION $\pi^-p \to p\pi^+\pi^-\pi^-$ AT 6 GeV/c. Crennell, David J.; Karshon, Uri; Lai, Kwan Wu; Scarr, J. Michael; Sims, W. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 24: 781-5(6 Apr 1970).

In a high-statistics experiment, well-defined threshold enhancements in the $\rho^0\pi^-$ and $f^0\pi^-$ systems were observed at 1120 and 1645 MeV, respectively. Other dominant decay modes of these enhancements were searched for and none found. The question of whether these objects are threshold enhancements of kinematic origin or resonances is examined. (auth)

24233 SURVEY OF EXPERIMENTAL RESULTS ON MULTI-PARTICLE PRODUCTION FROM HIGH ENERGY pp AND Kp COLLISIONS. Panvini, R. (Brookhaven National Lab., Upton, N. Y.). pp 461-508 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Experimental results are presented on multi-particle production from pp reactions for beam momenta ranging from 10 to 30 GeV/c from both counter and bubble chamber data. Some Kp bubble chamber results at ~10 GeV/c are presented for comparison. Several points of view of the data are taken and a few dominant features emerge. The ratios between various cross sections from "off-shell" π^-p scattering derived from 28.5 GeV/c pp data were compared with the corresponding ratios between "on-shell" π^-p cross sections resulting in good overall agreement. The "off-shell" or virtual π^- is assumed to be produced at a vertex where an incident proton transforms into an outgoing Δ^{++} at low $|t|$. In addition, differential cross sections are presented for reactions $pp \to pM$ at 28.5 GeV/c, where $M < 2.1$ GeV, and $pp \to \pi^{\pm}+$ (anything) at 12.2 and 12.5 GeV/c. The exponential slope of the momentum transfer distributions to either p in the first reaction or the $\pi^{\pm}$ in the latter reaction is very steep at low momentum transfers and much shallower at large momentum transfers. The above subjects are discussed in detail along with other general information. (auth)

24234 THE ROLE OF FIREBALLS IN N-N INTERACTIONS AT COSMIC-RAY ENERGIES. Shivpuri, R. K.; Jain, P. L. (State Univ. of New York, Buffalo). Lett. Nuovo Cim.; 3: 535-41(18 Apr 1970).

An analysis is presented for 18 jets observed in nuclear emulsions from N + N interactions at a primary energy of 0.4 to 100 TeV. The mass spectra of the fireballs and their production angles in the center-of-mass were determined. Also the results on cross sections of a pair of fireballs and the four-momentum transfer between the fireballs are discussed. It is concluded that while the distinction of fireballs on the basis of 1 log tg Θ distribution of the particles alone is ambiguous, the analytic separation as shown seems more reasonable. It is seen that the various features of ultrahigh-energy interactions such as the double-fireball formation and their mass and angular distribution follow as a natural consequence from the observed and kinematic features of the interactions without introducing any assumptions. (J.F.P.)

24235 SMALL-ANGLE ELASTIC SCATTERING OF ANTI-PROTONS AT 3 GeV/c IN NUCLEAR EMULSIONS. Kahn, R.; Scherer, M. (Laboratoire de Physique Corpusculaire, Caen, France). Nuovo Cim.; 66A: 675-92(21 Apr 1970).

An analysis of $\bar{p}$-(emulsion-nuclei) elastic scattering at 3 GeV/c for $0.001 \leq |t|\ (\text{GeV/c})^2 \leq 0.017$ was made using the model of Van Hove with four different forms of real parts and the optical model. All models indicate the presence of an attractive 10 to 20% real amplitude. Several parameters of these models have been obtained and others deduced. A comparison of the above models was made. (auth)

Strong (Meson-Induced)

Refer also to abstracts 23018, 24233, and 24376.

24236 (ANL/HEP-6909, pp 37-59) HIGH ENERGY PION PRODUCTION. Walker, W. D. (Wisconsin Univ., Madison).

A review is given of processes involving Pomeron exchange, that is, diffraction dissociation. Also reviewed qualitatively is multipion production. (J.F.P.)

24237 (ANL/HEP-6909, pp 60-72) MULTI-REGGEISM. Zweig, G. (California Inst. of Tech., Pasadena).

Multi-Regge exchange was looked for in the process $\pi^- + p \to \pi^- + X + p$, $X \to \pi^+ + \pi^-$ at 25 GeV in a bubble chamber. It is found that multi-peripheral events exist and are consistent with the multi-Regge exchange and that the cross section for multi-Regge exchange is 95 ± 10 μb. (J.F.P.)

24238 (COO-1195-178) THE K-ZERO PROTON PI-PLUS CHANNEL IN K-PLUS PROTON INTERACTIONS AT 3.2 GeV/c. Shufeldt, Warren Eugene (Illinois Univ., Urbana). Feb 1970. Contract AT(11-1)-1195. 72p. Dep. CFSTI.

Thesis.

The reaction $K^+p \to K^0_1p\pi^+$ was studied with a 3 ev/μb exposure in the ANL 30-inch hydrogen bubble chamber. The 5700 two-prong V^0 events in this film sample were measured on SMP's and processed with the Illinois programs SPACE-ILLFIT-GNUS. The reaction is found to be dominated by production of the quasi-two body final states K^*p and K^0N^*. The absorptive peripheral model has been compared to the K^* production data and although the spin density matrix elements show general agreement with its predictions, the differential cross section does not. The N^* production data are well described by the ρ and A_2 Regge pole model of Krammer and Maor. The dependence of momentum transfer distributions upon invariant masses is also discussed. (auth)

24239 STUDY OF $\omega \to \pi^+\pi^-$ IN $K^-p \to \Lambda\omega$ FROM 1.2 TO 2.7 GeV/c. Flatte, Stanley M. (Univ. of California, Berkeley). Phys. Rev., D; 1: 1-9(1 Jan 1970).

A general phenomenological method for studying a two-pion mass spectrum is developed; it is shown that, without assumptions about the production mechanism of the two-pion system, no significant upper limit on the $\omega \to \pi^+\pi^-$ branching ratio can be set with present-day experiments. In general, a lower limit may be set if a significant effect is seen. This method is applied to data containing more than 8000 $\omega \to \pi^+\pi^-\pi^0$ events. The lower-momentum half of the sample, which shows a significant $\omega \to \pi^+\pi^-$ signal, was published previously but is here reanalyzed to set a lower limit on the $\omega \to \pi^+\pi^-$ branching ratio. The new data at higher momenta show no significant $\omega \to \pi^+\pi^-$ signal. The results from the various momenta are shown to be consistent. (auth)

24240 XI-MINUS HYPERON PRODUCTION IN K^--p INTERACTIONS AT 5.5 GeV/c. Schultz, Peter Frank. Urbana, Ill.; Univ. of Illinois (1969). 167p.

Thesis.

The results of an investigation of the production of Ξ^- hyperons in K^-p interactions at 5.5 GeV/c are presented. The data were obtained from a 400,000 picture exposure of the MURA 30" hydrogen bubble chamber at the Argonne National Laboratory. Production cross sections for the Ξ^- final states and for the $\Xi^*(1530)$ and $K^*(890)$ resonances are given. Center of mass angular distributions in the 2, 3, and quasi-3 body final states are characterized by the forward peaking of the Ξ^-. An exception is the $\Xi^-K^+\Phi$ final state in which the Φ meson is observed to go forward in the center of mass. The $\Xi^-\pi$ distribution has evidence for the production of the $\Xi^*(1930)$ resonance. The mass and width are 1955 ± 14 MeV and 56 ± 26 MeV. A very narrow structure, $\Gamma < 30$ MeV, at a mass 2295 ± 15 MeV is observed in the $\Xi^-\pi^+\pi^-$ mass distribution of the 4 and 5 body final states. The mass of the Ξ^- is measured to be 1321.8 ± 0.4 MeV. Details of a search for and the identification of Ω^- hyperons are given. The mass of the Ω^- is measured to be 1671.8 ± 0.9 MeV as determined from three unambiguous cases of Ω^- production and decay. (Disser. Abstr.)

24241 A SPLITTING IN THE DECAY CHANNEL $A_2^- \to K^0_1K^-$ PRODUCED IN THE REACTION $\pi^-p \to pA_2^-$ AT 7 GeV/c. Baud, R.; Benz, H.; Bosnjakovic, B.; (and others) (CERN, Geneva). Phys. Lett.; 31B: 397-400(16 Mar 1970).

A $K^0_1K^-$ mass spectrum in the A_2 region was obtained in the reaction $\pi^-p \to pK^0_1K^-$ at 7 GeV/c. The double peak structure of the A_2 meson, observed in the earlier missing mass spectra, is found to be present also in the decay channel $A_2^- \to K^0_1K^-$. (auth)

24242 PRODUCTION AND NEUTRAL DECAY OF THE η MESON IN π^-p COLLISIONS. Richards, W. Bruce (Univ. of California, Berkeley); Chiu, Charles B.; Eandi, Richard D.; (and others). Phys. Rev., D; 1: 10-19(1 Jan 1970).

The reaction $\pi^- p \rightarrow \eta n$ was observed through the decay mode $\eta \rightarrow 2\gamma$ at T_π^- = 592, 655, 704, 875, 975, 1117, and 1300 MeV. The detection apparatus was a cubic array of six steel-plate optical spark chambers that completely surrounded a liquid-hydrogen target. Events attributed to the decay of an η were identified by the large c.m. opening angle between the two showers generated in the steel plates by the decay photons. The total cross section for η production was calculated, which is proportional to the number of events under the large-angle peak in the opening-angle distribution. The total cross section rises steeply from threshold to a maximum of about 2.4 mb at 650 MeV, and then falls gradually to about 0.66 mb at 1300 MeV. The differential cross section was obtained by taking the coefficients of a Legendre-polynomial fit to the angular distribution of bisectors of selected two-shower events, and converting them to the coefficients of the η c.m. angular distribution. The differential cross section is found to be isotropic at 592 MeV, to require terms through $P_2(\cos\theta_\eta)$ between 655 and 975 MeV, and to have a forward peak fitted by terms through $P_3(\cos\theta_\eta)$ at 1117 MeV and through $P_4(\cos\theta_\eta)$ at 1300 MeV. It is suggested that production at threshold is predominantly through an S state, with some P_1 and D_3 waves entering by 655 MeV. It is suggested that all the absorption in the S_{11} πN state can be explained by the η production. (auth)

24243 SIX-PRONGED $\pi^- p$ INTERACTIONS AT 6 BeV/c. Suen, K. F.; Alyea, E. D., Jr.; Galloway, K. F.; Martin, H. J., Jr.; Powers, W. E.; Small, T. M. (Indiana Univ., Bloomington). Phys. Rev., D; 1: 54-66(1 Jan 1970).

Results are presented from a study of 1983 six-prong $\pi^- p$ interactions observed in the ANL 30-in. hydrogen bubble chamber. The incident π^- momentum was 5.97 BeV/c. The measured cross sections for the $3\pi^- 2\pi^+ p$, $3\pi^- 2\pi^+ p\pi^0$, and $3\pi^- 3\pi^+ n$ final states are 0.25 ± 0.02, 0.35 ± 0.04, and 0.14 ± 0.03 mb, respectively. The general features of the data, e.g., the angular and momentum distributions of the individual particles in each final state, are presented, and agree with the results of experiments at other energies. Resonances are produced in more than half the events. The $\Delta^{++}(1236)$ isobar and the ρ^0 and ω^0 mesons dominate the resonance production. Associated production of the Δ^{++} isobar and the ρ^0 meson is observed in the $3\pi^- 2\pi^+ p$ final state. In the $3\pi^- 2\pi^+ p\pi^0$ final state, the Δ^{++} isobar and ω^0 meson are produced simultaneously. The A_1^- meson is observed in the $3\pi^- 2\pi^+ p$ final state. Evidence consistent with the production of higher resonances is also presented. (auth)

24244 ANALYSIS OF THE DECAY PROPERTIES OF THE Q. Farber, M. S.; Ferbel, T.; Slattery, P. F.; Yuta, H. (Univ. of Rochester, N. Y.). Phys. Rev., D; 1: 78-85(1 Jan 1970).

The decay characteristics of the low-mass Q^+ enhancement in the $(K\pi\pi)^+$ system which is produced in the reaction $K^+ p \rightarrow (K\pi\pi)^+ p$ at 12.7 GeV/c are presented. When treated as a single resonance, this enhancement has the properties expected for the strange member of an SU(3) meson octet with $J^{PC} = 1^{++}$. The resonance position and width of the Q are, respectively, 1260 ± 20 and 180 ± 20 MeV. (auth)

24245 SPIN-PARITY ANALYSIS OF A_2^1 AND A_2^H IN THE DECAY CHANNEL $A_2^- \rightarrow \rho^0\pi^-$. Baud, R.; Benz, H.; Bosnjakovic, B.; (and others) (CERN, Geneva). Phys. Lett.; 31B: 401-4(16 Mar 1970).

A Dalitz plot of the $\rho^0\pi^-$ system, obtained in the reaction $\pi^- p \rightarrow pA_2^-$ at 7 GeV/c, was analyzed separately for the two peaks of the split A_2 meson. For both peaks $J^P = 2^+$ is strongly preferred over other hypotheses. (auth)

24246 PROPERTIES OF $_\Lambda H^3$. Keyes, G. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Derrick, M.; Fields, T.; Hyman, L. G.; Fetkovich, J. G.; McKenzie, J.; Riley, B.; Wang, I.-T. Phys. Rev., D; 1: 66-77(1 Jan 1970).

The properties of the hypernucleus $_\Lambda H^3$ were measured in an analysis of helium-bubble-chamber pictures taken at the Argonne ZGS. Some 90 examples of the production reaction $K^- + {}^4He \rightarrow {}_\Lambda H^3 + p + \pi^-$ were found in which the K^- stopped and the $_\Lambda H^3$ decayed via π^- emission. Twenty-seven events were observed to decay via the two-body mode $_\Lambda H^3 \rightarrow \pi^- {}^3He$, with the remaining events decaying to $\pi^- pd$ or $\pi^- ppn$. The production rate was measured to be $(1.8^{+0.9}_{-0.6}) \times 10^{-3}$ per stopping K^-. The mean life of the hyperfragment was measured from the two-body decay mode as $(2.64^{+1.8}_{-0.9}) \times 10^{-10}$ sec. The lifetime obtained from the three-body decays was consistent with this value, after the elimination of a serious source of background. The binding energy of $_\Lambda H^3$ was measured to be 0.25 ± 0.31 MeV. The decay ratio $R_3 = \Gamma({}_\Lambda H^3 \rightarrow \pi^- {}^3He)/\Gamma({}_\Lambda H^3 \rightarrow$ all $\pi^-)$ was measured to be $0.36^{+0.14}_{-0.08}$, in agreement with values from previous experiments and with the value calculated for spin ½ for the $_\Lambda H^3$ hypernucleus. (auth)

24247 LOW-MOMENTUM $K^- - {}^4He$ SCATTERING. Mazur, P. O.; Block, M. M.; Keren, J.; Meyer, S. L. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 1: 20-6(1 Jan 1970).

The differential cross section for elastic scattering of K^- mesons on ^4He in the momentum intervals 100–150 MeV/c and 150–200 MeV/c, and the total inelastic cross section in the interval 150–200 MeV/c were measured. Scattering lengths for the K^--^4He system were calculated using the zero-effective-range approximation. The results for the scattering lengths were compared with other experiments, including a measurement of K^--mesonic x rays in ^4He. The results are in disagreement with the latter. (auth)

24248 $K^{\pm} p$ BACKWARD ELASTIC SCATTERING FROM 1 TO 7 GeV/c. Lundby, Arne (CERN, Geneva). pp 1-17 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

The results of experiments on $K^+ p$ and $K^- p$ elastic scattering are summarized. Cross sections, angular distributions, and the general slopes of the backward peaks were obtained. An attempt is made to interpret the data within the framework of the Regge formalism. (L.B.S.)

24249 POLARIZATION MEASUREMENTS IN MEDIUM-ENERGY ELASTIC SCATTERING AND HIGH-ENERGY MODELS. Andersson, S.; Daum, C.; Erne, F. C.; Lagnauz, J. P.; Sens, J. C.; Schmid, C.; Udo, F. (CERN, Geneva). pp 21-49 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

New data on π^+, π^-, K^+, K^-, p, and $\bar{p}$ elastic scattering on polarized protons at 2.74 GeV/c are discussed, with the aim of providing testing grounds for the low-energy extrapolation of high-energy theories. Polarization and differential cross section distributions were obtained simultaneously for pions, kaons, and protons. The data on πp are shown to be in agreement with predictions of a five-pole Regge model with parameters obtained from a fit to high-energy data; this fit was obtained using continuous moment sum rules. The pp and $\bar{p}p$ data are compared with a simple five-parameter optical model. This model appears to describe correctly the differential cross sections in this energy region, but fails to account for the details of the polarization data. The $K^+ p$ and $K^- p$ data at 2.74 GeV/c are compared with available Regge calculations for Kp elastic scattering; the trend of the data is generally well predicted. The possibility of including low-energy data in Regge calculations directly is examined. (L.B.S.)

24250 πp POLARIZATIONS IN THE INTERMEDIATE ENERGY REGION. Booth, N. E.; Conforto, G.; Esterling, R. J.; Parry, J.; Scheid, J.; Sherden, D. (Univ. of Chicago, Ill.); Yokosawa, A. pp 51-8 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Measurements of the polarizations in $\pi^+ p$ and $\pi^- p$ elastic scattering between 2.75 and 5.15 GeV/c are reported. Several features of the polarizations which can be explained on the basis of the Regge model persist to quite low energies. (auth)

24251 INELASTIC DIFFRACTIVE PROCESSES AT HIGH ENERGY. Franzini, Paolo (Columbia Univ., N. Y.). pp 97-126 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

A series of experimental results is presented for inelastic diffractive processes of the type A + B → B + X, where X is a state of many particles with certain restrictions on its quantum numbers which are found experimentally. The main experimental features of the πp, Kp and pp data are briefly discussed. 20 references. (L.B.S.)

24252 HIGH ENERGY π-NUCLEON COLLISIONS. Walker, W. D. (Univ. of Wisconsin, Madison). pp 295-328 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

A discussion of diffraction dissociation and multi-pion production in high energy π-nucleon collisions is given. Strange particle production at high energy is also discussed. The momentum distribution of various products of high energy π-p collisions is presented. A discussion of the multiplicity of both charged and neutral particles is given. (auth)

24253 A WIDE GAP SPARK CHAMBER MEASUREMENT OF $\alpha_0 P$ FOR SIGMA HYPERONS PRODUCED IN THE REACTION $\pi^+ p \rightarrow \Sigma^+ K^+$. Hoffman, Earl Wayne. Evanston, Ill.; Northwestern Univ. (1969). 94p.

Thesis.

A measurement was made of $\alpha_0 P$ for sigma hyperons produced in the reaction $\pi^+ p \rightarrow \Sigma^+ K^+$ and which subsequently decay via $\Sigma^+ \rightarrow p\pi^0$. The final state proton and the kaon were observed in wide gap spark chambers at incident pion momenta of 1106, 1134, and 1164 MeV/c. Only sigmas produced in the backward direction in the c.m. system were detected. This is the region of low production cross section and high polarization. Photometric measurements on the spark images were used to determine the relative ionizing power of the two observed particles, and hence, to resolve the ambiguity of the proton momentum and to exclude background events. These data contribute to previous measurements in a region that had very low statistics and yield a result more consistent with resonance model calculations than did previous data, especially at 1164 MeV/c. Comparing the results with a recent partial wave analysis of $\Sigma^+ K^+$, $\Sigma^0 K^0$, and $\Sigma^- K^+$ final states, shows that D waves are not needed for a satisfactory description of the polarization up to 1170 MeV/c. (Diss. Abstr. Int., B)

24254 DETERMINATION OF THE $\bar{K}NY_1^*$ COUPLING CONSTANT. Bunnell, K. O. (Northwestern Univ., Evanston, Ill.); Cline, D.; Laumann, R.; Mapp, J.; Uretsky, J. L. Lett. Nuovo Cim.; 3: 224-8(19 Feb 1970).

An experimental determination of the $\bar{K}NY_1^*$ coupling from an analysis of K^--meson absorption by deuterium is reported. The analysis is based upon an impulse approximation fit to the data and a model of the $\bar{K} + N \rightarrow \Lambda + \pi$ amplitude below the $\bar{K}$-nucleon threshold. It is concluded that the data are consistent with a value of $g_{\bar{K}NY_1^*}$ that is predicted on the basis of exact SU(3). (L.B.S.)

24255 EVIDENCE FOR CONSTRUCTIVE INTERFERENCE IN SMALL-ANGLE K^+p ELASTIC SCATTERING AT 5 GeV/c. Bellm, Th. H. J.; deJonge, H.; Meyer, R. W.; Tenner, A. G.; Vons, P.; Winzeler, H. (Univ., Amsterdam). Lett. Nuovo Cim.; 3: 389-94(21 Mar 1970).

A hydrogen bubble chamber is used to study $K^+ + p \rightarrow K^+ + p$ interactions at 4.98 GeV/c. This study is carried out as far down as possible into the Coulomb interference region. The standard fit, neglecting spin-flip contributions, to the obtained data gives a constructive real part with $\alpha = -0.52 \pm 0.11$. (J.F.P.)

24256 MEASUREMENT OF TOTAL AND PARTIAL CROSS SECTIONS OF 5.1 GeV/c π^- MESON INTERACTION IN PROPANE BUBBLE CHAMBER. Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; Dzhelepov, B. P.; Martinska, G.; Kladnitskii, V. S.; Lomakin, Yu. F.; Patochka, I.; Flyagin, V. B.; Shlyapnikov, P. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 395-8(Feb 1970). (In Russian).

The total cross section of the 5.1 GeV/c π^- meson interaction is measured in a propane bubble chamber. Yields of reactions with different multiplicity of charged particles are determined for the interaction of π^- mesons with protons, neutrons, and carbon and the cross sections of generation 0–10 prong events in collisions with proton are obtained. (auth)

24257 SPECTRUM OF CHARGED NON-STRANGE BOSONS IN THE MASS REGION FROM 3.0 TO 3.8 GeV. Baud, R.; Benz, H.; Bosnjakovic, B.; (and others) (CERN, Geneva). Phys. Lett.; 31B: 549-52(13 Apr 1970).

With the CERN Boson Spectrometer five new resonances have been found in the spectrum of charged non-strange bosons with masses between 3.0 and 3.8 GeV. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 24206.

General

Refer also to abstracts 23037, 23038, and 24454.

24258 HIGH ENERGY COLLISIONS. Third International Conference Held at Stony Brook, New York, September 5–6, 1969. New York; Gordon and Breach, Science Publishers, Inc. (1969). 529p. $27.50. (CONF-690928).

Separate abstracts are prepared for the eighteen papers included in the proceedings. (L.B.S.)

For abstracts of individual papers see: 24216, 24217, 24233, 24248–24252, 24298, 24299, 24339–24341, 24378–24380, 24400, and 24450.

24259 SOME CONSEQUENCES FROM THEORY OF PERIPHERAL INTERACTIONS. Akimov, V. N.; Roizen, I. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 11: 472-80(Feb 1970). (In Russian).

It is shown that the fireball model of inelastic interaction allows one to describe quantitatively the energy dependence of average multiplicity and generates the moving vacuum singularity determining the asymptotic behaviour of the corresponding part of the elastic scattering amplitude. The problem of the pre-asymptotic increase of the cross section is discussed. (auth)

24260 ON POSSIBLE APPEARANCE OF BRANCHING POINTS IN MULTIPERIPHERAL COLLISIONS. Boreskov, K. G. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 448-52(Feb 1970). (In Russian).

Contributions from the simplest branching points to the amplitude of transition of two particles into three, are considered. It is shown that the emission angle distribution of the intermediate (the slowest one) particle in c.m.s. is very sensitive to the presence of the branching points. (auth)

24261 CAN EQUATIONS OF MOTION BE USED IN HIGH-ENERGY PHYSICS. Dirac, P. A. M. Phys. Today; 23: No. 4, 29-31(Apr 1970).

The discussion of equations of motion for high-energy physics covers the S-matrix theory, Lorentz invariance, and quantum electrodynamics. The method is formulated, and the vacuum state, and solution interpretations are considered. (J.F.P.)

24262 PARTICLE PHYSICS FOR NUCLEAR PHYSICISTS. Lipkin, H. J. (Weizmann Inst. of Science, Rehovoth, Israel). pp 585-667 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

The approaches, methods, and problems of particle physics are discussed. The relations between corresponding features of nuclear and particle physics are stressed. The quark model, universality, symmetry and composite structure, and current algebra, and analyticity and pole dominance in nuclear and particle physics are treated. Also treated are quasispins in group theory for nuclear and particle physics, noncompact and time-dependent quasispins in the Lorentz group. (J.F.P.)

24263 BOUND STATES OF A THREE-PARTICLE NONRELATIVISTIC SYSTEM. Atanasov, A. A. (Higher Pedagogical Inst., Plovdiv, Bulgaria). Acta Phys. Pol.; A37: 334-43(1970).

The problem of finding the energies of the bound states of a three-particle nonrelativistic system with two-body interactions is reduced to the determination of the eigenvalues of a Hermitian operator. An algorithm is proposed, under certain assumptions concerning the two-body interactions, for approximate determination of the energies of the bound states in case of degenerate and nondeginerate states. In principle the energies can be determined with approximate accuracy. (auth)

24264 PHASE SPACE INTEGRAL AND PHYSICAL REGIONS FOR n PARTICLES IN INVARIANT VARIABLES. Morrow, Richard A. (Dartmouth Coll., Hanover, N. H.). Ann. Phys. (N. Y.); 57: 115-35(Mar 1970).

A simple prescription for writing down many formulations of the $(n-1)$-particle phase space integral in invariant variables is presented. Corresponding to each is a set of determinantal conditions which determines the physical regions of n-particle processes. Various forms of the phase space integral with a higher degree of symmetry are also given. Finally, the nonuniqueness of the 4-momenta for fixed values of the independent variables is discussed. (auth)

Electromagnetic

Refer also to abstracts 24195, 24333, 24380, 24424, 24450, and 24518.

24265 (ANL/HEP-6909, pp 150-8) INCOHERENT DROPLET MODEL AND MULTIPARTICLE PRODUCTION IN ELECTRON–PROTON COLLISIONS. Huang, Kerson (Massachusetts Inst. of Tech., Cambridge).

The incoherent droplet model which describes two-body large-angle hadronic scattering and multiparticle production in hadronic collisions, is briefly discussed and compared with hadron experiments. Then the inelastic electron–proton scattering is considered in the light of this model. (J.F.P.)

24266 LORENTZ CONTRACTION EFFECTS IN THE ELECTROMAGNETIC FORM FACTORS OF RELATIVISTIC TWO-BODY BOUND SYSTEMS. Mather, Lauren Richard. Urbana, Ill.; Univ. of Illinois (1969). 144p.

Thesis.

Relativistic effects in the electromagnetic form factors of a two-body bound system are discussed by examining specific examples in detail. The wave function for the two-body bound system is calculated from the Bethe-Salpeter equation and inserted

into form factor expressions for scalar and vector photons. Even in the Breit frame, the charge density is distorted due to relativistic effects. The resulting form factor is compared to a static form factor which is calculated by not allowing the relativistic distortion in the charge density to occur. At low momentum transfers, relativistic distortion causes the initial slope of the form factor, plotted as a function of q^2, to be greater in magnitude than the static case. This gives the system an apparent mean square radius that is larger than the actual mean square radius. At large momentum transfers the relativistic and static form factors appear to have the same functional form but differ in magnitude by a constant factor. The scalar photon form factor was three times greater and the vector photon form factor five times greater than the static form factors for the particular model that was considered. (Disser. Abstr.)

24267 LOCAL CURRENT ALGEBRA SUM RULES AND ELECTRON–POSITRON ANNIHILATION INTO BARYONS. Chanowitz, M. S. (Cornell Univ., Ithaca, N. Y.). Phys. Lett.; 31B: 374-8(16 Mar 1970).

A set of local current algebra sum rules which can be studied in e^+e^- colliding beam experiments is derived. With saturation assumptions, the nucleon isovector radius and the slope at threshold for $\sigma(e^+e^- \to N\bar{N})_{I=1}$ and $\sigma(e^+e^- \to N\bar{\Delta})_{I=1}$ are calculated. (auth)

24268 FORWARD COMPTON SCATTERING SUM RULES AND J = 0 SINGULARITIES. Dominguez, C. A.; Ferro Fontan, C.; Suaya, R. (Univ., Buenos Aires). Phys. Lett.; 31B: 365-7(16 Mar 1970).

A J = 0 singularity in the spin averaged forward proton Compton amplitude was found using continuous moment sum rules. Its residue coincides with the Thomson limit. Values for the Regge parameters of P and P′ were also obtained. (auth)

24269 RADIATIVE X^0 DECAYS IN BROKEN SU(3). Singer, Paul (Deutsches Elektronen-Synchrotron, Hamburg. Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 1: 86-8(1 Jan 1970).

The radiative decays of the X^0 meson are analyzed in the framework of an effective Lagrangian with vector-meson dominance, using vector gauge fields with current mixing and assuming X^0 to be a unitary singlet. The underlying VVP strong interaction obeys octet-broken SU(3) symmetry. The model is shown to predict branching ratios different from those obtained in the η-X^0 mixing model. An analysis of the experimental situation is presented, and the relevance of the $X^0 \to 2\gamma$, $X^0 \to \omega\gamma$ partial decay modes for distinguishing between different theoretical models is pointed out. (auth)

24270 PRODUCTION OF SINGLE W MESONS IN ELECTRON-POSITRON COLLIDING BEAMS AND IN ELECTRON OR MUON SCATTERING EXPERIMENTS. Berends, F. A.; West, Geoffrey B. (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2076. Phys. Rev., D; 1: 122-9(1 Jan 1970).

Total cross sections for the production of single W mesons in electron-positron colliding beams and in the electron scattering experiments were calculated. If the first type of cross sections are estimated by calculating the simplest lowest-order dominant Feynman graph, it is found that they are remarkably large ($\sim 10^{-30}$ cm^2). Indeed, a calculation in the literature which includes all lowest-order contributions apparently confirms this result. These estimates are in striking disagreement with calculations for the related process of neutrino-induced production of single W mesons. These suggest a cross section of $\sim 10^{-37}$ cm^2, a result which is to be expected from a naive power-counting argument. The cross sections were calculated and were found to be quite small and of the same order of magnitude as the neutrino-induced cross sections. A general gauge-invariance argument is presented which illustrates how almost any trivial error in the calculation can easily lead to errors in the result of at least [(mass of the proton)/(mass of the positron)]$^2 \sim 10^6$. Basically, gauge invariance demands a critical cancellation in the differential cross section when the mass of the exchanged photon (K^2) becomes very small. If such a cancellation does not take place (because of some small error), the region around $K^2 = 0$ is enormously enhanced by the smallness of the mass of the positron, and large errors are induced in the final result. An examination of the calculations that lead to a large total cross section does indeed show that each violates the constraint of gauge invariance. (auth)

24271 ELECTROPRODUCTION OF NUCLEON RESONANCES AND IMPLICATIONS FOR COINCIDENCE EXPERIMENTS. Pritchett, P. L.; Zucker, P. A. (Stanford Univ., Calif.). Phys. Rev., D; 1: 175-87(1 Jan 1970).

The general form of the coincidence cross section for electroproduction of nucleon resonances is reviewed and discussed using the helicity formalism. The predictions of a coupled-channel relativistic N/D model are discussed for nucleon levels in the first four resonance regions. These predictions serve to indicate important questions concerning the structure of the nucleon, and consideration is given as to how these questions may be answered by means of coincidence experiments. (auth)

24272 VECTOR-DOMINANCE MODEL AND PHOTOPRODUCTION OF PIONS. Brown, Stanley G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 1: 207-13(1 Jan 1970).

The relation between the processes $\gamma + N \to \pi + N$ and $\pi + N \to \rho + N$, according to the vector-dominance model (VDM), is re-examined. The VDM is defined in terms of the behavior of the invariants in the matrix elements of the vector current. The consequences of the VDM, and assumptions about asymptotic properties for measurable quantities are discussed. The inability of the VDM to account for the results of polarized-photoproduction experiments is confirmed. An appendix provides a detailed discussion of the relation between invariants and density matrix elements in various frames. (auth)

24273 VENEZIANO MODEL FOR COMPTON SCATTERING OF PIONS. Ahmad, Masud; Fayyazuddin; Riazuddin (Univ. of Islamabad, Pakistan). Phys. Rev., D; 1: 213-16(1 Jan 1970).

Compton scattering of pions is investigated in the Veneziano model. It is shown that the removal of parity doubling causes undesirable features, such as inconsistency with the low-energy theorem or the appearance of an unwanted pole in the energy variable ($s = 0$) in one of the amplitudes. If the problem of parity doubling or the pole at $s = 0$ is ignored, a sum rule is obtained which closely resembles that obtained from superconvergence relations or the quark model, or current algebra. (auth)

24274 APPLICATION OF A RELATIVISTIC RESONANCE FORMULA TO THE $e^+e^- \to \pi^+\pi^-$ EXPERIMENT. Parkinson, Michael (Syracuse Univ., N. Y.). Phys. Rev., D; 1: 368-72 (1 Jan 1970).

The present data for the reaction $e^+e^- \to \pi^+\pi^-$ are analyzed with the aid of a general effective-range resonance formula for the ρ meson. It is concluded that (a) $m_\rho = 769 \pm 5$ MeV and $\Gamma_\rho = 109 \pm 10$ MeV provide a reasonable explanation of the present experimental points; (b) the full width at half-maximum regardless of the peak height should give an excellent estimate of the ρ width; (c) it is hard to escape $|F_\pi(m_\rho^2)|^2 = m_\rho^2/\Gamma_\rho^2$; (d) the effects of final-state interactions on resonance shape ought to be investigated. (auth)

24275 COHERENT ρ^0 PHOTOPRODUCTION IN COMPLEX NUCLEI. Gottfried, Kurt (Massachusetts Inst. of Tech., Cambridge. Cornell Univ., Ithaca, N. Y.); Julius, David I. Contract AT(30-1)-2098. Phys. Rev., D; 1: 140-51(1 Jan 1970).

A description of coherent ρ photoproduction is given that takes the rather substantial width of the ρ into proper account. The optical-model analysis due to Drell and Trefil is extended to include ρ decay inside the nucleus, as well as the subsequent absorption of the decay pions. The eikonal method is used throughout, and is found to yield compact analytic expressions for the production amplitude. The decay effects produce an appreciable shift of the ρ peak towards lower mass for production in heavy nuclei and at the lower photon energies of current interest (2.7 – 4.5 GeV). On the whole, the differential cross sections are not significantly affected in either shape or magnitude by the effects arising from ρ decay. In particular, the decay corrections do not appreciably influence the determination via vector dominance of the ρ-photon coupling constant. (auth)

For abstracts of individual papers see: 24211, 24212, 24277–24290, and 24424.

24276 PROCEEDINGS OF THE 4th INTERNATIONAL SYMPOSIUM ON ELECTRON AND PHOTON INTERACTIONS AT HIGH ENERGIES, LIVERPOOL, SEPTEMBER 14th–20th, 1969. Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969). 328p. Pound 6. (CONF-690947).

Seventeen papers submitted to the Symposium are reproduced in full and abstracts only are given for 167 other papers. Discussions are included for the 17 papers, and separate abstracts are included in this issue of NSA for these papers. (UK)

24277 SINGLE PION PHOTOPRODUCTION IN THE RESONANCE REGION. Walker, R. L. (Calif. Inst. of Tech., Pasadena). pp 23-41 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969). See CONF-690947.

A brief review is given of the more conspicuous features of pion photoproduction in the resonance region, together with a discussion on how all of these features can be more or less predicted by a simple quark model. Recent data which can be used to improve experimental knowledge are surveyed. (63 references) (UK)

24278 PSEUDOSCALAR MESON PHOTOPRODUCTION. Lubelsmeyer, K. (Univ., Bonn). pp 45-67 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

Pseudoscaler meson photoproduction experiments above the s-channel resonance region are discussed under the following headings: charged pion photoproduction (π^+ and π^- production from protons and neutrons; π^+ and π^- production with polarized photons; comparison with theoretical models); neutral pion and eta meson photoproduction; charged K meson photoproduction; charged $\pi\Delta$ (1236) photoproduction; photoproduction at backward angles (pions; $K^+\Lambda$ and $K^+\Sigma^0$); photoproduction of mesons from complex nuclei (charged pions and K^+ mesons; π^0 mesons). Conclusions reached are as follows: (1) Results of photoproduction experiments with polarized photons and the experiments with neutrons give quite detailed information of the different parity and isoamplitudes contributing to the total production amplitude. (2) In the case of charged and neutral pion photoproduction, models based on Reggeized particle exchange, including a background due to absorption or conspiring trajectories, can describe the data. (3) The lack of a pronounced dip in η and backward π photoproduction throws serious doubts on the explanation of dips to wrong signature nonsense zeros of the contributing Regge trajectories. (4) The results of production of $K\Sigma$ and $\pi\Delta$ from protons and neutrons indicate that at least 10% contributions are present with $I = 3/2$ for $K\Sigma$ and $I = 2$ for $\pi\Delta$. (5) The vector dominance model predicts the combined π^+ and π^- asymmetry very well when the density matrix elements are evaluated in the Donohus–Hogassen system. The prediction for the sum of the transverse π^+ and π^- cross sections is poor for intermediate t values, and the poor predictions for π^0 and $\pi\Delta$ production may arise from bad hadronic cross sections. (57 references) (UK)

24279 VECTOR-MESON PHOTOPRODUCTION. Silverman, A. (Cornell Univ., Ithaca, N. Y.). pp 71-87 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

Topics discussed are (a) vector meson photoproduction; (b) interaction of photons with complex nuclei; and (c) search for high mass vector mesons. The current status is reviewed, with particular emphasis on the interpretation of results by vector-meson dominance. Headings are as follows: ρ-photoproduction on hydrogen; photoproduction of ρ-mesons with polarised photons; ρ-production on deuterium; ω-production on hydrogen; ϕ-production from hydrogen; photon absorption in complex nuclei; incoherent π^+ and ρ-photoproduction; vector-meson photoproduction on complex nuclei; ϕ-photoproduction on complex nuclei; and search for high mass vector-mesons. (49 references) (UK)

24280 VECTOR-MESON DOMINANCE: PRESENT STATUS AND FUTURE PROSPECTS. Sakurai, J. J. (Univ. of Chicago). pp 91-104 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

The subject is discussed under the following headings: Introduction; current-field identity; comparison of $\rho^0 \to e^+e^-$ and $\rho^0 \to \pi^+\pi^-$; ρ-photon analogy; single-pion photoproduction and frame dependence; vector-meson photoproduction and total photoabsorption cross sections; table of the ρ-meson coupling constant; broken SU(3) and ω-ϕ mixing; classical vs. frontier region; possibility of more vector-mesons; asymtotic behaviour of the colliding beam cross section; nucleon form factor; inelastic electron-proton scattering; and future experiments. (68 references) (UK)

24281 PHOTO PRODUCTION MECHANISMS. Harari, J. (Weizmann Inst. of Science, Rehovoth, Israel). pp 107-19 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

Some of the general qualitative features of photoproduction data which are of immediate interest to current theoretical ideas are discussed. It is stated that the most interesting aspect of available data is the remarkable similarity between ordinary hadronic processes and hadron photoproduction. "Elastic" photoproduction of neutral vector-mesons closely resembles elastic hadronic processes, while "inelastic" photoproduction of pions, K-mesons, etc., has much in common with hadron-initiated inelastic collisions. It is also considered that photon beams are as useful as hadron beams for exploring the properties of the strong interactions. In photoproduction processes, however, many difficulties and discrepancies are encountered by simple exchange models at high energies. Topics discussed are as follows: "inelastic" photoproduction-general features; "inelastic" photoproduction-small t behaviour; the dip at $|t| \approx 0.6$ GeV^2 and the double faced ρ and ω trajectories; backward photoproduction; exotic exchanges (mesons outside SU (3) decuplets and octets; baryons outside singlets, octets and decuplets); the elusive ρ meson; new tests of SU(3); photoproduction of A_2; vector-meson photoproduction and total γ N cross-sections; vector-meson dominance and photoproduction mechanisms. Among conclusions reached are the following: (1) Photons are hadron-like in their interactions with hadronic matter, and the general features of photoproduction processes are remarkably similar to those of ordinary hadron reactions. (2) Regge poles are incapable of providing a reasonable picture of photoproduction processes, but Regge cuts and/or absorption corrections are needed. (3) There are preliminary indications for the existence of exotic t-channel amplitudes, and it is crucial to verify this experimentally in photoproduction and other-hadronic processes. (4) The vector-meson dominance model is a reliable qualitative guide to possible connections between photon reactions and hadron reactions, but its quantitative success is limited. (5) Nuclei are not transparent to photons, and details of high energy photo-nucleus interactions are not yet well understood. (34 references) (UK)

24282 N* ELECTRO PRODUCTION: EXPERIMENTAL RESULTS. Clegg, A. B. (Univ. of Lancaster, Eng.). pp 123-38 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

A compilation is presented of all available experimental information concerning γ NN* form factors, and an attempt is made to give the information in such a way that the results of different experiments can be compared and related. It is hoped to obtain information about the structures of the various N* resonance by comparing the inelastic form factors with the elastic form factors, and there is some indication that this is beginning to happen with the Δ (1236). Phenomenological analysis of the existing data is attempted, but this shows how much more information is needed. Topics considered include: transverse excitation of Δ resonance; longitudinal/scalar excitation in Δ region; excitation of s-wave-background; excitation of second and third resonance peaks; and comparison with proton inelastic scattering. Among conclusions revealed is that some information is being obtained about the relation between the structure of the Δ resonance and that of the nucleon. (41 references) (UK)

24283 ELECTRO PRODUCTION OF BARYON RESONANCES (THEORY). Gutbrod, F. (Deutsches Elektronen-Synchrotron, Hamburg). pp 141-59 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

Definitions of transition form factors are given, together with general remarks on composite models, and a description of the Born term model. Dispersion theory is discussed, including Adler's model, Zagury's model, variation techniques, box diagram contributions, and dispersion relations in q^2. The Bethe–Salpeter theory for $\Delta(1236)$ is also described, higher resonances are considered, and the quark model is discussed. (78 references) (UK)

24284 NUCLEON FORM FACTORS. Rutherglen, J. G. (Univ. of Glasgow). pp 163-74 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).
See CONF-690947.

The basis for the analysis of elastic scattering cross sections in terms of form factors is summarized; the evidence for the validity of this analysis is discussed. The present state of the experimental data is reviewed, particularly in relation to the scaling law and the dipole fit. Some theoretical fits to the data are also discussed. Topics discussed are as follows: Elastic scattering in the one-photon approximation; second order effects (validity of the Rosenbluth formula); experimental data on form factors (proton form factors; neutron form factors); comparison with theory (vector dominance; the quark model; Veneziano models; pion form factor). (42 references) (UK)

24285 HIGH ENERGY ELECTRO PRODUCTION. Gilman, F. J. (Stanford Linear Accelerator Center, Calif.). pp 177-92

of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

The main subject of this paper is the constitution of nucleons, for which neither the constituents nor the forces are known. Lack of understanding of strong interaction dynamics presents much in the way of quantitative predictions. Plans of attack for extracting information on the composite structure of the nucleon through electron scattering should endeavour to use either aspects of available data which are independent of strong interaction dynamics, such as the approximate position and shape of a quasi-elastic peak, or which involve only general aspects of strong interaction processes which are fairly well understood, such as the high energy behaviour of total cross sections. The implications of experimental data are discussed under the following headings: Kinematics and the experimental data; point-like constituents — the parton model; diffraction models; field theory models; and related processes and implications. It is concluded that there are two quite different viewpoints which can be used to explain present data. Within the parton model these may be regarded as those involving dominantly a small number of interacting partons (e.g. three quarks) and those involving dominantly an infinite number of partons (e.g. a sea of quark-antiquark pairs). Regarded from a t-channel point of view in virtual Compton scattering the first possibility corresponds to "ordinary" exchanges (like P', P, A_2, ...) being responsible for most of the cross section while the second corresponds to Pomeron exchange. In the first case the Adler sum rule has a good chance of being right, while in the second it is very likely wrong. A real choice between the two models will most likely come from electroproduction off neutrons. From the first kind of model sizable differences are in general expected with respect to the proton, while in the second model the neutron and proton should be the same. With regard to exploring the ν-q^2 plane experimentally what a few years ago was essentially a wilderness has now been mapped in a qualitative way, and in many cases some quantitative details are known. (53 references) (UK)

24286 MUON PHYSICS. Toner, W. T. (Stanford Linear Accelerator Center, Calif.). pp 195-209 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

Experiments with high energy muons which have recently been completed or which are in progress are discussed. It is stated that the main problem in muon physics is that it is not understood why it should exist. High energy muon scattering should be dominated by the electromagnetic interaction, and the electromagnetic interactions of the muon are well understood. There is always the possibility that muons may be a better tool than electrons for exploring some aspects of particle physics, on account of the smaller electromagnetic backgrounds and corrections resulting from the larger mass of the muon. Topics discussed are: Muon tridents; elastic muon scattering; the SLAC muon beam; the SLAC muon scattering equipment; interpretation of data; results of the SLAC experiment on hydrogen (low q^2 data; muon-electron comparison; high q^2 data); scattering from complex nuclei; and cosmic ray muons. (41 references) (UK)

24287 e^+-e^- ANNIHILATION INTO HADRONS (SUM RULES AND ASYMPTOTIC BEHAVIOR). Gatto, R. (Univ., Padua). pp 235-44 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

The increasing role of e^+-e^- colliding beam reactions in providing important clues in the field of particle physics is emphasized, and attention is directed to some theoretical questions which have received recent consideration, in particular to current algebra results which have a bearing on the sum rules and asymptotic behaviour relevant to e^+-e^- collisions. (33 references) (UK)

24288 APPLICATIONS OF CURRENT ALGEBRAS TO ELECTROPRODUCTION. Furlan, G. (Univ., Trieste, Italy. International Centre for Theoretical Physics, Trieste, Italy). pp 245-9 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

The success of the current algebra approach to elementary particle physics is emphasized and predictions which may be deduced therefrom are discussed; these are mainly of two kinds, namely sum rules and low energy theorems. In particular, a systematic procedure for exploiting current algebra information for physical pion amplitudes, which has been applied to electroproduction, is discussed. (8 references) (UK)

24289 INELASTIC ELECTRON–PROTON SCATTERING IN THE DEEP CONTINUUM REGION. Taylor, R. E. (Stanford Linear Accelerator Center, Calif.). pp 251-60 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

Reference is made to some preliminary results on e-p inelastic scattering at 6° which were previously presented, and a striking feature of which was the large cross section for excitation of the proton in the continuum region, above the region of resonance excitation. The analysis of data for 6° and 10° has now been completed, and some preliminary results have been obtained for some larger angle data. Experimental and data reduction details are given and the behaviour of the cross sections is discussed together with the application of sum rules. Among the conclusions reached are: (1) The cross section in the continuum $W > 2$ GeV shows a much weaker q^2 dependence than elastic scattering and resonance excitation. (2) In the continuum region the absorption cross section for transversely polarized virtual photons is greater than that for longitudinally polarized virtual photons, and varies approximately as $1/q^2$. (3) The structure function $\sqrt{W_2}$ appears to "scale," that is, it is a function of only $2/q^2$ to within the accuracy of the data (approximately ± 10%). (4) Both "diffraction" models and "parton" models can be constructed to fit the data, but the detailed models of ρ-dominance proposed by Sakurai and others fail at large angles for high q^2. Further experimental work in this field is outlined. (17 references) (UK)

24290 THE PHASES OF VECTOR-MESON PHOTOPRODUCTION AMPLITUDES AND RHO–OMEGA INTERFERENCE. Allcock, G. R. (Univ. of Liverpool). pp 261-6 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

A report is given on two interference experiments which yield information on the relative phase of the forward no-helicity flip ρ and ω photoproduction amplitudes on nuclei. The process studied is the reaction $\gamma + A \rightarrow A + (\rho, \omega)\ e^+e^-$. It has been usual to discuss such processes in terms of vector-meson dominance, applied to the nucleus as a whole, but vector dominance may work well in elementary processes the mass extrapolation on which it relies for its definitive prediction is not completely valid in nuclei. The A-dependence of the photoproduction cross sections shows this clearly, exhibiting a behaviour intermediate between that expected for scattering of a hadron and that for scattering of a weakly interacting particle. The foregoing reaction was investigated at DESY using photons of 5.12 GeV energy incident on a thin ^{9}Be target, and at Daresbury using photons of 4.1 GeV incident on a thin ^{12}C target; a description of both experiments is given and the results are discussed. Some theoretical ideas concerning the nature of the processes involved are introduced; these ideas depend only on the fact that in a nucleus the coherent scattering, which leaves the nucleus in its ground state, is dominated at small angles and high energies by a co-operative contribution in which the scattered wavelets from the various nucleons struck build up in phase to give a large amplitude. The angular region within which this reinforcement takes place is small, being of the order of the ratio λ wavelength to nuclear radius, and the nuclear scattering may be treated as if dealing with spinless particles, helicity flip being left out of consideration. It was extremely important that both experiments were performed within the narrow nuclear diffractive region. Otherwise the interpretation would not be clear. Allowances are indicated for bremsstrahlung and multiple scattering. Comparison of the results of the two experiments suggests an unexpectedly large energy variation of both ϕ and η; this could be due to an unexpectedly large nuclear physics effect, but other calculations do not contain large nuclear physics effects for small A values. A further problem in the interpretation of the two experiments is that the m peaks is contaminated by incoherent ρ, ω production, in which the nucleus is excited or broken up; a correction of 5% to the spectrum at the ω peak is estimated for this. Some remarks are included about the problem of photoproduction phases and the real past of the photoproduction amplitude on nucleons. Finally, an introduction is made of some of the similar ideas of analytic S-matrix theory, giving some feeling for the ρ-amplitude on nucleus. Presumably the amplitude for scat-

tering of ω on nucleus is similar, but the amplitude on nuclei is more difficult. (11 references) (UK)

24291 CONTRIBUTION OF VARIOUS FEYNMAN DIAGRAMS RELATING TO THE PROCESS $ee \rightarrow ee A\bar{A}$. Arteaga-Romero, Napoleon; Jaccarini, Antoine; Kessler, Paul (Laboratoire de Physique Atomique, Paris). Compt. Rend., Ser. B, 269: 1129-33 (3 Dec 1969). (In French).

The contribution of secondary diagrams was calculated for the process $ee \rightarrow ee A\bar{A}$ (A being a muon, pion or kaon), that is to say diagrams other than those for the exchange of two photons. It is proven that under the kinematic conditions considered (high initial energies, scattering angles limited to a few degrees for the two electrons), this contribution is practically negligible. (tr-auth)

24292 CHARGE AND MAGNETIZATION DISTRIBUTIONS OF THE PROTON. Ino, T. (Shimane Univ., Matsue, Japan); Yonezawa, M. Lett. Nuovo Cim.; 1: 592-4(21 Apr 1969).

It is shown that the deviation of the proton form factors from the dipole fit seems to suggest that the dipole distributions of charge and magnetization of the proton are distributed at the short distance $r \lesssim 1.5 \times m_p^{-1}$. The appearance is shown of some diffraction patternlike feature in the form factor associated with the range, and the consistency of this with the experimental data is pointed out. (J.F.P.)

24293 HIGH-ENERGY ep INELASTIC SCATTERING IN A RENORMALIZABLE THEORY. Chang, Shau-Jin; Fishbane, Paul M. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 24: 847-50(13 Apr 1970).

The ep deep inelastic scattering in a neutral pseudoscalar-meson theory was studied without imposing a cutoff on the transverse momentum, by summing an infinite set of diagrams. The main results are that the final particles fall naturally into two jets, the Bjorken scaling law breaks down, multiplicity of pions increases as $\log q^2$, and a longitudinal impact parameter space is realized. (auth)

24294 FIXED POLES IN VIRTUAL COMPTON AMPLITUDES. Cheng, T. P.; Tung, Wu-ki (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Lett.; 24: 851-4(13 Apr 1970).

It is suggested that the leading fixed-pole terms in virtual Compton amplitudes are polynomial functions of the photon mass variable q^2. Several arguments are given in support of this conjecture. Implications of this behavior in the calculation of the electromagnetic mass differences and in the q^2 dependence of the e-p inelastic-scattering structure functions are discussed. (auth)

24295 FINAL-PARTICLE CORRELATIONS IN DEEP INELASTIC LEPTON PROCESSES. Drell, Sidney D.; Yan, Tung-mow (Stanford Univ., Calif.). Phys. Rev. Lett.; 24: 855-9 (13 Apr 1970).

A study is made of the additional information learned from measurements of the correlation of two (or more) detected particles in the final states of deep inelastic lepton processes. Generalized Bjorken limits are derived in which the new structure functions depend only on the ratios of the kinematical variables available, just as do the more familiar structure functions W_1 and νW_2 for electron-proton scattering in the deep inelastic region. Experimental implications are discussed. (auth)

24296 VENEZIANO FORMULA FOR COMPTON SCATTERING OF PIONS. Ferrari, C. A.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Lett. Nuovo Cim.; 1: 568-70(21 Apr 1969).

An expression for the $\omega\pi\rho$ coupling is obtained from the Veneziano model for the Compton scattering of charged photons by pions. (J.F.P.)

24297 STUDIES OF SOME ASPECTS OF INTERACTIONS OF ELECTRONS AND MUONS WITH MATTER AND APPLICATION OF FERROMAGNETISM. Kelkar, V. B. Bombay; Bombay Univ. (1968).

Thesis.

The nuclear scattering of 14-MeV neutrons, the anomalous scattering of high energy muons and the scattering of high energy electrons by carbon and oxygen were studied. It is proved that the interactions of muons and electrons with matter are electromagnetic. A mathematical condition was found to determine the spin structure in 180° ferromagnetic domain walls. The energy of a 180° block wall is determined by analyzing the experimental data on the distortion of these walls due to electric currents. The equilibrium shape and distortion of the Neel wall and 90° wall are also studied. (Indian Sci. Abstr.)

24298 VECTOR MESON DOMINANCE AND NUCLEAR OPTICS. Gottfried, Kurt (Cornell Univ., Ithaca, N. Y.). pp 207-26 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Recent experiments that are designed to test vector meson dominance are described. Coherent photoproductions of vector mesons are briefly described; qualitative tests of vector meson dominance are then discussed. Several conclusions are made, one of which is that vector meson dominance cannot be universally valid. 22 references. (L.B.S.)

24299 THEORY OF HIGH ENERGY DIFFRACTION SCATTERING. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. pp 329-65 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

High-energy scattering processes in quantum electrodynamics are treated. Electron scattering in an external field is first discussed. The scattering amplitude for the scattering of a high-energy photon by the static field is obtained, using the old perturbation method. The considerations are extended to a general problem of scattering in a potential using impact diagrams. Rules for calculating the impact diagrams are discussed and examples are given for electron-electron scattering, electron Compton scattering, photon-photon scattering, double Compton scattering, radiative correction to electron scattering, bremsstrahlung and pair production. Some physical features obtained from quantum electrodynamics are generalized to strong interactions. (L.B.S.)

24300 NEUTRON-PROTON BREMSSTRAHLUNG CALCULATIONS. McGuire, J. H. (Northeastern Univ., Boston). Phys. Rev., C; 1: 371-6(Feb 1970).

The neutron-proton bremsstrahlung cross section between 14 and 208 MeV is calculated by including the external radiation terms to all orders in the momentum of the photon, K, and by using the low-energy theorem to compute the internal scattering contribution to order K^0. These calculations, which employ a simple off-shell extrapolation of the elastic phase shifts, are in good agreement with the data at 208 MeV. These off-shell calculations are also compared to calculations using the corresponding on-shell phase shifts in order to determine the strength of the off-shell terms. In coplanar scattering where $\theta_p + \theta_n \leq \sim 60°$, these off-shell effects constitute as much as 50% or more of the cross section, while for $60° \leq \theta_p + \theta_n \leq 90°$, the off-shell contributions are much smaller. (auth)

24301 RESONANT SCATTERING OF ELECTROMAGNETIC WAVES ON ELECTRONS IN MAGNETIC FIELD AND ELECTRON POLARIZATION. Loskutov, Yu. M.; Leventuev, V. P. (Moscow State Univ.). Yadern. Fiz.; 11: 411-15(Feb 1970). (In Russian).

Resonant scattering of photons on electrons placed in a magnetic field is considered. The dependence of the scattering cross section on the frequency, angular distribution of initial photons and on the electron polarization is obtained. It is shown, that in the process of resonant scattering, the electron beam polarization takes place. (auth)

24302 MANY-PHOTON POLARIZED BREMSSTRAHLUNG. Nadzhafov, I. M. (Moscow State Univ.). Yadern. Fiz.; 11: 416-24(Feb 1970). (In Russian).

Differential cross sections are calculated for two-, three-, and four-photon bremsstrahlung from electron in nuclear field in the case of any energy and small scattering angles. Longitudinal electron polarizations and circular photon polarizations are taken into account, some regularities in the many-photon bremsstrahlung are established. The scattering angles may decline from 0 and π by as many as several degrees. In particular it is shown that even numbers of hard bremsstrahlung photons are mainly emitted at small angles. (auth)

24303 MESON ELECTROPRODUCTION ON POLARIZED PROTON. Omelaenko, A. S. (Physical-Technical Inst. of Low Temperatures, Kharkov). Yadern. Fiz.; 11: 425-9(Feb 1970). (In Russian).

The electroproduction process $ep \rightarrow en\pi^+$ on a polarized proton is considered. Contributions to the cross section which are due to the polarization of the target are calculated in a general case. The sensitivity of these contributions to the form factor of π meson and to the charge form factor of neutron G_{EN} is estimated in the region of the first πN resonance. The asymmetry for the particular case of the forward electroproduction is calculated. (auth)

24304 INVERSE COMPTON EFFECT, PAIR PRODUCTION, AND PENETRATION OF HIGH-ENERGY ELECTRONS AND PHOTONS THROUGH THE METAGALAXY. Berezinskii, V.

(Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 11: 399-410(Feb 1970). (In Russian).

General formulas are obtained for the energy losses of electrons due to the inverse Compton effect and for the probability of pair production by photons on the electromagnetic radiation with arbitrary spectrum. Interaction of electrons and photons of high and superhigh energies with the relic radiation and with the r.f. radiations, as well as with the magnetic fields in the metagalaxy, is considered. Nowadays, the universe is not transparent to the electrons with energies $E \geq 10^8$ eV and to the photons with energies $E \geq 10^{11}$ eV. (auth)

24305 CHARGED-PARTICLE DRIFT MOTION. Malyshev, V. A. (Taganrogskii Radiotechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 119-25(1969). (In Russian).

A differential equation is derived describing the change in time and average-energy for random motion of a particle which drifts in an electric field. Different variants of this equation are considered, and also the equations of motion following from it and the special cases of their solution. Questions are discussed concerning changes in the drifting particle time coordinate, the average rate of drift, and the volt-ampere characteristic of the drift region for the space-charge limitation of the current. (tr-auth)

24306 VAVILOV-CHERENKOV POLARIZATION BY ELECTRONS IN A TRANSPARENT UNIAXIAL CRYSTAL. Kukanov, A. B. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 108-14(1969). (In Russian).

The quantum theory of Vavilov–Cherenkov radiation by electrons in a transparent uniaxial crystal was examined. Cases were studied in which the electron initially moves along the optical axis of the crystal and perpendicularly to it. The radiation polarization was studied. (tr-auth)

24307 FORM FACTOR MODELS AND CHIRAL SYMMETRY. Frampton, P. H. (Univ. of Chicago). Contract AT(11-1)-264. Lett. Nuovo Cim.; 3: 229-34(19 Feb 1970).

A method previously suggested for deriving a model formula for an hadronic form factor is to relate the four-point function to the three-point function by the techniques of current-field identities, current algebra, and soft-pion extrapolations. A problem encountered in this approach is that the vector and axial vector currents are not treated in a symmetrical fashion. Using a more general and symmetrical approach, it is shown how it is possible to find an infinite class of solutions for the vector and axial vector form factors, consistent both with the related four-point functions and with the chiral properties of the vector currents. (L.B.S.)

24308 REGGE TRAJECTORIES IN NUCLEAR PHOTOPRODUCTION. Rej, A. K. (Indian Statistical Inst., Calcutta). Lett. Nuovo Cim.; 3: 526-8(18 Apr 1970).

The importance of inelastic photoproduction of pions and vector mesons in isolating various important Regge trajectories is discussed. Thus a better study of the individual Regge trajectories is suggested by studying nuclear photoproduction phenomena. In this way if one considers inelastic photoproduction processes leading to an appropriately chosen excited state of the nuclear system, using linearly polarized photons, various Regge trajectories entering into the amplitude of the different photoproduction reactions can be isolated. (J.F.P.)

24309 REGGE POLES AND $\pi\Delta(1236)$ PHOTOPRODUCTION. Zotov, N. P.; Nelipa, N. F. (Univ. of Friendship of Nations, Moscow). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 103-6(1969). (In Russian).

In the framework of the Regge pole model expressions for the differential cross sections and the isobar polarization density matrix for the process $\gamma + N \rightarrow \pi + \Delta(1236)$ were obtained with the calculation of ρ, A_2, and π trajectories. (tr-auth)

24310 ELECTRIC DIPOLE MOMENT EFFECTS ON THE POLARIZATION OF SPINOR PARTICLES IN A MAGNETIC FIELD. Loskutov, Yu. M.; Leventuev, V. P. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 152-4(1969). (In Russian).

The effects of the electric dipole moment on the spin orientation of a particle which moves in a homogeneous and constant magnetic field are studied. From previous work it follows that if one passes longitudinally polarized particles through a perpendicular magnetic field, then the particles with spin which possess an electric dipole moment will emerge from the plane of motion, thereby violating symmetry relative to this plane. For example, if one passes perpendicularly to the magnetic field, initially longitudinally polarized mesons (μ), the magnetic field strength and meson energy being selected so that half the spin precession period, i.e., $\tau/2 = \pi/\omega \approx \pi\hbar/2H\mu$, and the lifetime of the moving meson (μ) are equal, then the decay electrons will be distributed asymmetrically relative to the plane of motion of the mesons. (tr-auth)

24311 WAVE EQUATIONS OF PARTICLES WITH ZERO MASS. Holmaas, O. (Univ. of Bergen). Nuovo Cim.; 66A: 789-96(21 Apr 1970).

It is shown that the Dirac and Weyl theories of zero-mass particles with spin $\frac{1}{2}$, can be generalized to the case of arbitrary spin $s > 0$. In particular it is shown that the wave equations of zero-mass particles with spin 1, are the correct photon equations. If the spin matrices are expressed in the Cartesian representation, these equations reduce to the Maxwell equations for free, circularly polarized, electromagnetic waves. (auth)

24312 ON THE THEORY OF THE PION ELECTROMAGNETIC FORM FACTOR. Baier, V. N.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nuovo Cim.; 66A: 693-707(21 Apr 1970).

An analysis of the behavior of the pion form factor at $t \rightarrow \pm\infty$ was carried out under some definite assumptions on the property of the form factor as an analytic function in a complex plane of the momentum transfer t. Bounds on the modulus of the form factor and the electromagnetic radius of the pion were found. The method was formulated which permits one to obtain the integral representations of the form factor, and some definite representations were obtained. The sum rules for the form factor were found and analyzed, and some questions connected with the usage of the sum rules were considered. The experimental situation of today for the pion form factor was discussed. (auth)

24313 EQUAL-TIME COMMUTATORS AND NON-REGGE BEHAVIOR OF PION PHOTOPRODUCTION AMPLITUDES. Dosch, H. G.; Mueller, V. F. (Univ., Heidelberg. Kernforschungszentrum, Karlsruhe, Ger.). Ann. Phys. (N. Y.); 56: 430-52(Feb 1970).

It is shown that fixed poles in photoproduction amplitudes emerge from the equal-time commutators in a natural way, the latter ones being the consequence of an assumed sharply retarded commutator in the reduction formula. It is discussed in detail, how the residues of these fixed poles which under the smoothness assumption are proportional to a strong form factor can be modified and cancelled. Such a cancellation seems to be rather artificial and necessitates the existence of a Kronecker delta in the retarded commutator of the pion current and the electromagnetic current. The fixed poles due to the equal-time commutators discussed occur only in negative-parity helicity amplitudes and hence are evasive. (auth)

24314 ON THE SPIN-PARITY OF THE X^0 (960) MESON. Gtler, S.; Klosinski, J.; Lefik, W.; Tybor, W. (Univ. of Lodz, Poland). Acta Phys. Pol.; A37: 475-6(1970).

The decay $X^0(960) \rightarrow \eta\pi^+\pi^-$ is analysed in the current algebra approach. The argument in favour of $J^P = 2^-$ assignment for the X^0 (960) meson is given. (auth)

24315 SUM RULES FOR FORWARD VIRTUAL COMPTON SCATTERING. Burkhardt, Hugh; Cottingham, W. N. (Univ. of Birmingham, Eng.). Ann. Phys. (N. Y.); 56: 453-63(Feb 1970).

A family of sum rules is presented which relate the proton electromagnetic form factors to proton electroproduction cross sections. These sum rules provide a test of the local commutation properties of the electric current operators. (auth)

Weak

24316 THEOREM ON K_{l3} FORM FACTORS. Fayyazuddin; Riazuddin (Univ. of Islamabad, Pakistan. International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 361-2(1 Jan 1970).

A simple proof of a theorem derived recently by Dashen and Weinstein on K_{l3} form factors is presented. With the further assumption that $D(t) \equiv \langle\pi|\partial_\lambda V_\lambda{}^1|K\rangle$ is dominated by the 0^+ κ meson, a relation between κ-meson mass and $f_K/f_\pi F_+(0)$ is obtained. (auth)

24317 K_{l3} FORM FACTORS, k-MESON WIDTH, AND SYMMETRY BREAKING. Fayyazuddin; Riazuddin (Rutherford High Energy Lab., Chilton, Eng. Univ. of Islamabad, Pakistan). Phys. Rev., D; 1: 317-20(1 Jan 1970).

A symmetry-breaking mechanism is used to derive a sum rule between f_K, f_π, and f_κ, the decay constants for K, π, $\kappa \rightarrow l + \nu$. By means of the sum rule f_K/f_π, f_κ/f_π and $f_+(0)$ (the form factor which enters in K_{l3} decay) are expressed in terms of the κ-meson mass and the experimentally known number $f_K/f_\pi f_+(0)$. The second-order SU(3)-symmetry-breaking corrections to $f_+(0)$ are found to be small. The K_{l3} form factors are determined. The $\kappa \rightarrow K\pi$ width is determined and in certain cases is found to be the same as in the Veneziano model. (auth)

24318 THEORY OF Ω^- DECAY. Goswami, D. N.; Schechter, J. (Syracuse Univ., N. Y.). Phys. Rev., D; 1: 290-8(1 Jan 1970).

The Ω^- nonleptonic decays are investigated in the framework of a chiral Lagrangian model. In this way, ambiguities of extension of meson momenta to zero which are present in the current-algebra approach are made explicit. It is found that these decays may possess a rather complicated structure and a discussion of approximation schemes is given which may help to explain the present experimental data. The approximation of the $\Xi 2\pi$ decay mode by $\Xi^*\pi$ is also discussed. (auth)

24319 NONLEPTONIC DECAYS OF THE Ω^- IN THE CURRENT-CURRENT MODEL. Ram Mohan, L. R. (Purdue Univ., Lafayette, Ind. Univ. of Sussex, Brighton, Eng.). Contract AT(11-1)-1428. Phys. Rev., D; 1: 266-73(1 Jan 1970).

The decuplet parity-conserving weak spurion was evaluated in the Sugawara-Suzuki model by assuming that the relevant matrix elements, in a current × current model, are saturated by baryon octet and decuplet single-particle intermediate states. SU(6) symmetry was used to determine the decuplet form factors at zero momentum transfer. In this approach, octet dominance for the decuplet spurion emerges in a natural manner. The P-wave Ω^- decay amplitudes are obtained with the baryon octet and decuplet spurion strengths as input. By assuming that the D-wave amplitudes for $\Omega^- \to \Lambda K$, $\Xi\pi$ decays are given by the K^*-pole model, a zero asymmetry parameter is predicted for $\Omega^- \to \Lambda K$ and a maximal one ($\alpha \approx 1$) is predicted for $\Omega^- \to \Xi\pi$ decays. The total decay rate of the Ω^- is estimated to be $\Gamma(\Omega^-) \cong 8 \times 10^9$ sec^{-1}, which is in good agreement with experiment. (auth)

24320 PION-POLE MECHANISM AND THE APPLICATION OF THE VENEZIANO MODEL TO $K_2^0 \to \pi^+\pi^-\gamma$ DECAY. Rockmore, Ronald (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., D; 1: 226-9(1 Jan 1970).

The CP-conserving decay mode $\pi^+\pi^-\gamma$ of the K_2^0 is calculated in the pion-pole model (with η-π^0 mixing) with the strong-interaction part of the decay amplitude described by the Veneziano model. Because of sign ambiguities introduced by a model of physical PVV couplings (which fits both $\pi^0 \to 2\gamma$ and $\eta \to 2\gamma$ rates) and the unknown sign of η-π^0 mixing relative to the weak K-π mixing, values of the branching ratio $r[(K_2^0 \to \pi^+\pi^-\gamma)/(K_2^0 \to \text{all modes})]$ are obtained ranging from 7.6×10^{-5} to 3.1×10^{-4}, but all are consistent with the present experimental upper limit of 4×10^{-4}. (auth)

24321 RADIATIVE CORRECTIONS TO $K_{\mu 3}$ DECAYS. Ginsberg, Edward S. (Technion Israel Inst. of Tech., Haifa). Phys. Rev., D; 1: 229-39(1 Jan 1970).

The radiative corrections to the Dalitz plot for $K_{\mu 3}^+$ and $K_{\mu 3}^0$ decays, assuming a phenomenological weak K-π vertex and using perturbation theory, are calculated. The answer depends logarithmically on a cutoff. All terms which contribute to order α analytically, without any approximations concerning the smallness of the muon mass or the "real inner bremsstrahlung" are evaluated. Thus, the dependence on parameter ξ (the ratio of the form factor f_-/f_+) is exact. The radiative corrections to the $K_{\mu 3}^0$ Dalitz plot, muon spectrum, and lifetime average around 2% over most of their respective ranges and are not especially sensitive to the cutoff. The radiative correction to $K_{\mu 3}^+$ decays is a fraction of a percent over most of the Dalitz plot and is sensitive to the cutoff. The radiative correction to the $\Delta I = \frac{1}{2}$ rule prediction for the ratio of the charged and neutral decay rates is approximately 2%. The final-state Coulomb correction accounts for most of this numerical result, the rest being model-dependent noise. (auth)

24322 EFFECTIVE LAGRANGIAN FOR NONLEPTONIC HYPERON DECAYS WITH SU(3) x SU(3)-SYMMETRY BREAKING. Ahmed, K.; Murtaza, G.; Harun-Ar Rashid, A. M. (Univ. of Islamabad, Pakistan. International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 1: 240-3(1 Jan 1970).

The hadronic decays of hyperons are discussed in the context of broken chiral symmetry, the breaking being introduced according to the prescription of Gell-Mann, Oakes, and Renner. The corrections due to symmetry breaking lead to contributions to the p-wave amplitudes, giving better agreement with the experimental data, whereas the s-wave amplitudes remain almost unchanged. (auth)

24323 CONSTRAINTS ON η_{00} FROM ELECTROMAGNETIC C VIOLATION. Horwitz, Paul (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 1: 244-9(1 Jan 1970).

Assuming that the hadronic electromagnetic current contains an isoscalar C-even part, the soft-pion technique and pole dominance are used to determine the isospin of the final state in the CP-violating part of the $K^0 \to 2\pi$ amplitude. If the usual dimensional arguments for the order of magnitude of the amplitude hold, as they appear to do for the observed value of η_{+-}, then values of η_{00} close to η_{+-} are excluded. (auth)

24324 STRANGENESS-CHANGING LEPTONIC DECAY OF HADRONS IN THE FRAMEWORK OF UNIVERSAL FERMI THEORY. Pradhan, T.; Pattnaik, Mamata (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., D; 1: 200-6(1 Jan 1970).

It is shown that the suppression of $\Delta S = 1$ leptonic decay modes of hadrons relative to the $\Delta S = 0$ modes can be successfully explained within the framework of the universal Fermi interaction by suitable assumptions regarding hadron states and weak hadron currents in the presence of symmetry-breaking effects. (auth)

24325 MUON-PROTON SCATTERING AND NE'EMAN'S FIFTH INTERACTION. Basri, Saul A. (Colorado State Univ., Fort Collins). Phys. Rev., D; 1: 165(1 Jan 1970).

The contribution of Ne'eman's fifth χ interaction to the muon-proton cross section is shown to be in disagreement with recent experimental results. This conclusion is based upon the value of g_χ suggested by Ne'eman, the value of g_χ/m_χ consistent with high-energy p-p scattering, and the assumption that the χ form factors are not appreciably different from the one-photon-exchange form factors. The conclusion is not changed by a reasonable variation of the values of g_χ and m_χ. (auth)

24326 NONLEPTONIC HYPERON DECAYS. Shimada, Junichi. Philadelphia; Univ. of Pennsylvania (1969). 93p. Thesis.

Suzuki-Sugawara's theory of S-wave nonleptonic hyperon decay is reviewed to see to what extent their theory tests current algebra and current x current form of interaction. The only argument for current x current form in nonleptonic decays that is at all compelling is the vanishing of the S-wave amplitude $A(\Sigma_+^+)$ for the decay $\Sigma^+ \to n + \pi^+$. In the soft-pion formalism for S-wave amplitude, the $\Delta I = \frac{1}{2}$ and pseudo $\Delta I = \frac{1}{2}$ rules follow from chiral invariance, and the Lee-Sugawara relation from W_1-invariance. In a general chiral and W_1-invariant theory $A(\Sigma_+^+) = 0$ only because of an artificial cancellation between the 27- and 10-parts of the nonleptonic weak Hamiltonian; in a current x current theory, $\mathcal{H}_W^{NL}$ (10) is absent and $A(\Sigma_+^+) = 0$ is an expression of octet dominance. For the P-wave decay, to which soft-pion formalism is inapplicable, an octet model, including Bludman's kaon pole term, is used. To fit the empirical P-wave amplitudes, strong coupling shifts are required in both the S- and P-waves. Including SU(3) symmetry breaking leads to parity violating Born terms in the S-waves. To estimate the parity violating spurion coupling, the kaon tadpole model and $K_{2\pi}$ decay rate are used. If pionic and kaonic strong coupling constants are suppressed by $\frac{2}{3}$ and $\frac{1}{3}$, all the S- and P-wave amplitudes are given within 20%, with the exception of $A(\Sigma_+^+)$ which is now not precisely vanishing. If $A(\Sigma_+^+) = 0$ exactly is insisted on, then the suppression of strong coupling constants by $\frac{2}{3}-\frac{1}{3}$ is necessary. (Disser. Abstr.)

24327 OCTET DOMINANCE AND THE d/f RATIO IN NONLEPTONIC HYPERON DECAYS. Mathur, V. S.; Subba Rao, J. (Univ. of Rochester, N. Y.). Phys. Lett.; 31B: 383-6(16 Mar 1970).

Under the assumption that the quadratically "divergent" terms dominate the matrix elements for nonleptonic decay, the model of Gell-Mann et al., extended to include terms transforming as the $(8,1) \oplus (1,8)$ representation of SU(3) ⊗ SU(3), is shown to lead to octet dominance, near equality of d/f ratios for weak and medium strong mass splittings, and an instability in the solution of the Cabibbo angle as obtained by Gatto et al. (auth)

24328 THEORY OF THE TOTAL EXPERIMENT FOR LEPTONIC DECAYS OF HYPERONS. Belavin, A. A.; Solov'ev, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 437-43(Feb 1970). (In Russian).

The expression for differential probability of leptonic decay of a polarized hyperon is found and fitted in the comparison with the experiment taking into account all the complex form factors. Using this expression one can determine experimentally the values of form factors at fixed momentum transfer. (auth)

24329 POLE MODEL FOR NONLEPTONIC AND RADIATIVE HYPERON DECAY. Potashev, A. G. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 17-22(1969). (In Russian).

Nonleptonic and weak radiative decays of hyperons were examined according to the pole model. Unlike previous work contributions from both baryon and mesons poles were taken into account. On the basis of experimental data concerning these decays, parameters were obtained for effective weak two-baryon interactions. (tr-auth)

24330 POLARIZING EFFECTS IN THE REACTION $e \to e' + \nu_e + \bar{\nu}_e$ IN A MAGNETIC FIELD, μ-e DECAY. Loskutov, Yu. M.; Zakhartsov, V. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 98-103(1969). (In Russian).

The reaction $e \to e' + \nu_e + \bar{\nu}_e$ for relativistic electrons in weak

and strong magnetic fields is considered with calculation of polarization states. It is shown that with high probability this process yields left-hand polarized electrons. With very strong fields the considered effect must almost always produce left-hand polarized electrons. It is also shown that this reaction, as also synchrotron radiation, gives an electron polarization in a direction relative to the field. In conclusion the effect of a magnetic field on (μ–e) decay is considered. (tr-auth)

24331 ON A THEOREM ABOUT THE FORM FACTORS IN K_{l3} DECAY. Denardo, G. (Univ., Trieste, Italy). Lett. Nuovo Cim.; 3: 319-22(7 Mar 1970).

An elementary and independent derivation of a previous theorem, in which the quantities expressing the matrix element for the semileptonic decay of the kaon were given a relation showing the existence of an underlying SU(3) × SU(3) symmetry, is given. In this derivation the three-body leptonic decay parameters in the framework of an approximate SU(3) × SU(3) symmetry are related through current algebra techniques. (J.F.P.)

24332 REFINED QUARK MODEL OF WEAK HADRON DECAYS. Flamm, D.; Majerotto, W. (Institut fuer Hochenergiephysik, Vienna). Nuovo Cim.; 66A: 797-806(21 Apr 1970).

A refined quark model which includes vector-meson exchange is applied to nonleptonic and semi-leptonic decays. It resolves the difficulties of the quark model with the nonleptonic p-wave amplitudes and gives throughout good results. In particular the model predicts $\Gamma(\Omega \to \Xi\pi)/\Gamma(\Omega \to \Lambda K) = 1.03$ and $\Gamma(\Omega \to \Xi^*\pi)/\Gamma_{total} = 0.21$. (auth)

24333 FINAL-STATE INTERACTION AND CURRENT ALGEBRA IN $K_{3\pi}$ AND $\eta_{3\pi}$ DECAYS. Neveu, A.; Scherk, J. (Faculte des Sciences, Orsay, France). Ann. Phys. (N. Y.); 57: 39-64 (Mar 1970).

In a simple model of final-state interaction, the validity of the linear extrapolation in $K \to 3\pi$ and $\eta \to 3\pi$ decays is discussed. Final-state interaction modifies the extrapolation between the physical points where the soft-pion approximation is valid by introducing quadratic and higher terms in the amplitude. Computation of the effect in the frame of the Khuri-Treiman equation shows that they are dominated by the $\pi\pi$ scattering in each of the two pions subchannels, so that the corrections come out mainly from two-body scattering effects. Comparison with current algebra, Veneziano model and experiment for the rates, slopes, quadratic terms in $K \to 3\pi$ and $\eta \to 3\pi$ decays is given. (auth)

Strong (General)

Refer also to abstracts 24377 and 24450.

24334 (ANL/HEP–6909, pp 73-113) EXPERIMENT AND MULTIPERIPHERAL THEORY FOR SMALL MULTIPLICITY REACTIONS. Allison, W. W. M. (Argonne National Lab., Ill.).

The review of multiperipheral theory covers the general features of double peripheral production, the results of a recent experiment analyzed with a Reggeized double peripheral model, and lastly an analysis of the Reggeized multiperipheral model. It is found that the data show the expected behavior of exponential type t-distributions corresponding to permitted exchanges and the absence of unpermitted exchanges. There is evidence for the characteristic form of the Regge cross section. (J.F.P.)

24335 (ANL/HEP–6909, pp 159-80) MODELS BASED ON RELATIVISTIC GAS DYNAMICS FOR PRODUCTION REACTIONS. Fenster, S. (Argonne National Lab., Ill.).

The Landau model which is based on the concept of a hadron fluid obeying the laws of relativistic fluid dynamics is discussed. This model has a definite mathematical formulation in terms of the Euler equation of motion for an ideal fluid, and a fundamental length which determines the volume and critical temperatures is the only parameter. Properties of the hadron fluid, a collision model, and the identification of particles with hydrodynamical quantities are treated. It is concluded that the theory in its present form requires development for comparison with data. (J.F.P.)

24336 VERY-HIGH-ENERGY INELASTIC HADRON–HADRON COLLISIONS. Rajaraman, R. (Inst. for Advanced Study, Princeton, N. J. Univ., Delhi). Phys. Rev., D; 1: 118-21(1 Jan 1970).

A framework is suggested for interpreting processes of the type a + b → a + b + (n pions) at energies from tens to hundreds of GeV. The model predicts, without any adjustable parameters, the observed average transverse momenta of the pions in the entire range, as well as the existence and observed masses of "fireballs." The advantages of this model over the multi-Regge models are discussed. (auth)

24337 HELICITY CONSERVATION IN DIFFRACTION SCATTERING. Gilman, F. J.; Pumplin, J.; Schwimmer, A.; Stodolsky, L. (Stanford Univ., Calif.). Phys. Lett.; 31B: 387-90(16 Mar 1970).

The possibility is discussed that diffraction scattering of hadrons conserves the s-channel helicities of the particles involved. Presently available experimental data are examined and shown to support conservation of s-channel helicity, and not the hypothesis of no helicity flip in the t-channel. Further tests are suggested and restrictions imposed on various models of diffraction scattering in particular, t-channel exchange models, are discussed. (auth)

24338 REMARK ON THE GROSS–CALLAN–SUGAWARA COMMUTATOR AND THE THEORY OF CURRENTS. Zee, A. (Harvard Univ., Cambridge, Mass.). Lett. Nuovo Cim.; 1: 581-2(21 Apr 1969).

It is pointed out that explicit calculations employing the four-point functions of Gerstein and Schnitzer fail to verify the Gross–Callan–Sugawara commutator. (J.F.P.)

24339 REMARKS ABOUT THE POMERANCHUK THEOREM. Martin, Andre (CERN, Geneva). pp 227-30 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

The theoretical consequences of the violation of the Pomeranchuk theorem are examined. (L.B.S.)

24340 BEHAVIOR OF HADRON COLLISIONS AT EXTREME ENERGIES. Feynman, Richard P. (California Inst. of Tech., Pasadena). pp 237-58 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

A brief summary is first given of some properties and regularities in the high-energy behavior of hadron collisions. The behavior expected from field theory is then discussed, beginning with partons as the fundamental bare particles underlying the theory. Some special considerations dealing with Regge exchanges are described. Suggestions for the limiting behavior of cross sections at high energies are presented. (L.B.S.)

24341 HYPOTHESIS OF LIMITING FRAGMENTATION. Yang, C. N. (State Univ. of New York, Stony Brook). pp 509-18 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

A brief report is given on the hypothesis of limiting fragmentation in high-energy collisions. The hypothesis asserts that in a collision between two hadrons the projectile and the target fragment separately. The fragments from the target approach a limiting probability distribution when viewed in the laboratory as the incident energy increases. Similarly, the fragments from the projectile approach a limiting probability distribution in the projectile system where the projectile was initially at rest. The relation of the hypothesis to pionization is discussed. (L.B.S.)

24342 REMOVAL OF THE DIVERGENCE OF A PLANAR DUAL-SYMMETRIC LOOP. Frye, G.; Susskind, L. (Yeshiva Univ., New York). Phys. Lett.; 31B: 537-40(13 Apr 1970).

The nature of the divergence in the planar loop dual amplitude is examined. The divergent part is isolated and subtracted. The subtraction is Regge behaved and is essentially unique. (auth)

24343 ELASTIC SCATTERING OF HIGH-ENERGY PARTICLES AT LARGE ANGLES. Azimov, S. A.; Arushanov, G. G.; Khalmuradov, R. S. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 7-11(1969). (In Russian).

Using the Euler–MacLaurin sum rule, the sum of a number of scattering amplitudes is calculated in the case of high-energy hadron scattering at angles near 180°. With certain probable assumptions concerning the behavior of partial amplitudes the scattering cross section at these angles, normalized to the scattering cross section at 180°, is expressed by one parameter. Good agreement was obtained with existing experimental data for π^+p scattering. (tr-auth)

Strong (Baryon No. = 0)

Refer also to abstracts 24380 and 24425.

24344 NUMERICAL APPROACH TO THE LOW-ENERGY π-π BOOTSTRAP. Arbab, Farzam; Donahue, J. T. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 217-25(1 Jan 1970).

The π-π amplitude in the low-energy region is parametrized in a crossing-symmetric way as the sum of the ρ and f^0 resonance poles plus a polynomial background. The parametrization is flexible and capable of producing amplitudes having quite different features in the energy region below 1 GeV. The parameters are then varied so as to minimize the deviation from elastic unitarity on a set of closely spaced points. In addition, negative-moment finite-energy sum rules are used to connect the low-energy region with assumed Regge asymptotic behavior in the I = 1, 2 amplitudes. With the mass and width of the f^0, the mass of the ρ, and the slope of the ρ trajectory fixed, an approximate solution satisfying the constraints is found, yielding a ρ width of 80 ± 30 MeV. The solution displays the usual characteristics of the low-energy π-π amplitudes suggested by other analyses, namely, small scattering lengths and a large I = 0 S-wave phase shift near the mass of the ρ. This resonantlike behavior is found without introducing an S-wave pole in the parametrization, while the small scattering lengths are obtained as results of the numerical bootstrap, although no current-algebra constraints are included. The proposed solution is also found to satisfy various inequalities proposed by Martin for the $\pi^0\pi^0$ scattering amplitude. (auth)

24345 CALCULATION OF THE ρ-EXCHANGE CONTRIBUTION TO THE PION ELECTROMAGNETIC FORM FACTOR. Aubrecht II, Gordon J. (Princeton Univ., N. J.). Phys. Rev., D; 1: 284-9(1 Jan 1970).

Including ρ contributions in the crossed channels of the $\pi\pi$ scattering amplitude, the N/D method is used to obtain an expression for the pion electromagnetic form factor. The correction to the formula based on a direct-channel ρ pole is somewhat larger than generally believed, but still consistent with the recent colliding-beam experiments. (auth)

24346 DERIVATION OF RELATIONS OF THE KAWARA-BAYASHI-SUZUKI-RIAZUDDIN-FAYYAZUDDIN TYPE. Singer, Paul (Northwestern Univ., Evanston, Ill. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 1: 321-5(1 Jan 1970).

An alternative method for deriving Kawarabayashi-Suzuki-Riazuddin-Fayyazuddin- (KSRF-) type relations, which uses a low-energy theorem in quantum electrodynamics, is presented. The method is applied to processes of the kind $V \to P + P' + \gamma$. The amplitude for this process is exactly calculable to order zero in the photon momentum k in terms of the strong vertex $i_{VPP'}(m_V{}^2, m_P{}^2, m_{P'}{}^2)$, with all particles on the mass shell. KSRF-type relations are obtained when the momentum-independent term from the series expansion (in powers of the photon momentum) of the radiative amplitude is equated with the parallel term obtained from an explicit calculation of the amplitude. The latter calculation involves the use of current-algebra, partial conservation of axial-vector current, and hard-pion techniques. The derivation is worked out in detail for the $\rho \to \pi^+\pi^-\gamma$ process, and the method is further considered in connection with the appropriate radiative decays of ϕ^0 and K^{*0} mesons. (auth)

24347 FEYNMAN DIAGRAM MODELS OF DAUGHTER REGGE TRAJECTORIES. Steele, David Leon. Urbana, Ill.; Univ. of Illinois (1969). 146p.

Thesis.

The Van Hove model of Regge poles is used to study daughter trajectories of bosons in scalar meson-scalar meson scattering and of fermions in backward pion-nucleon scattering. Both the simple model with bare propagators and a generalized model that includes propagator self-energy insertions are considered. It is found that, in the simple model, the second boson daughter and the first fermion daughter are fixed (as a function of the squared momentum transfer t or u) double poles in complex J-plane. When self-energy corrections to the propagator are included, the fixed double pole breaks up into a moving daughter trajectory and a moving aunt trajectory. It is found that away from t(u) = 0, the daughter and aunt trajectories get mixed up in a complicated and model-dependent manner. (Disser. Abstr.)

24348 DUALITY AND LOW ENERGY PARAMETERS. Kugler, M. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett.; 31B: 379-82(16 Mar 1970).

Using duality it is proved that, in some reactions, low energy parameters are determined by resonances alone, regardless of the background. The success of the Veneziano formula in predicting the Adler zero in $\pi\pi$ and πK scattering and its failure in $\pi\eta$ and πX^0 scattering are explained. (auth)

24349 ABSOLUTE BOUND ON CROSS-SECTIONS AT ALL ENERGIES AND WITHOUT UNKNOWN CONSTANTS. Yndurain, F. J. (CERN, Geneva). Phys. Lett.; 31B: 368-70(16 Mar 1970).

It is proved that the total cross-sections for $\pi\pi$ scattering are bounded at all energies by a given inequality valid for all $n \geq 1$. At high energies, the right-hand side becomes essentially the Froissart bound without unknown constants. (auth)

24350 VENEZIANO MODEL WITH SECONDARY TERMS FOR PION-PION SCATTERING. Vasavada, Kashyap V. (Univ. of Connecticut, Storrs). Phys. Rev., D; 1: 88-94(1 Jan 1970).

It is shown that the Veneziano-Lovelace one-term formula for pion-pion scattering, although a good first approximation, has some undesirable features. With the help of a few secondary terms, a model amplitude which is consistent with the known properties of the pion-pion system up to the f^0 mass region and the high-energy phenomenology is constructed. (auth)

24351 HADRON COUPLINGS IN BROKEN SU(6) X O(3). II. MESON DECAYS. Choudhury, D. K.; Mitra, A. N. (Univ., Delhi). Phys. Rev., D; 1: 351-7(1 Jan 1970).

The phenomenological prescriptions outlined in paper (I) for meson-baryon couplings in a quark model of broken SU(6) × O(3) are employed for the construction of meson couplings in an almost identical spirit in respect of relativistic generalization as well as the inclusion of the recoil contribution. The multiplying form factor for a supermultiplet transition from an initial $Q\bar{Q}$ state (mass M) to a final $Q\bar{Q}$ state (mass m) is assumed to have the analogous structure $f_L(k^2) = \bar{g}_L \mu^{-L-1}(\mu/m_\rho)^{\alpha}(\mu/\omega_k)^{L+1}(2M)$, where $\bar{g}_L$ is a free parameter different from g_L for all cases except L = 0 (when both are equal to the $\bar{Q}QP$ coupling constant f_ρ). The agreement of this meson coupling scheme with experiment is found to be extremely good for a large number and variety of decays from $L^P = 0^-$, 1^+, and 2^- supermultiplets. These results not only provide a sensitive test of the (rapidly varying) structure of the form factor, but also serve to emphasize the essential unity of description of both meson and baryon couplings through a common set of assumptions. A more sensitive test of this model is provided by its polarization predictions for $B \to \omega\pi$ and $A_1 \to \rho\pi$ decays which are appreciably different from, and in somewhat better experimental accord than, those of the simple quark model. (auth)

24352 ASYMPTOTIC SYMMETRY, $A_1\rho\pi$ SYSTEM AND ANOMALOUS MAGNETIC MOMENT OF A_1. Acharya, R. (Univ., Bern). Lett. Nuovo Cim.; 1: 612-14(21 Apr 1969).

The strong decay $A_1 \to \rho + \pi$ is studied. The study of the parameter δ, which is used to express the A_1 and ρ widths and which is related to the anomalous magnetic moment of the A_1, shows that the study of the three-point functions can determine δ. The technique of asymptotic symmetry is applied to the three-point functions and it is thus shown that it leads to a unique determination of the parameter δ. It is predicted that $\delta = -\frac{1}{3}$ in complete agreement with the value recently obtained. (J.F.P.)

24353 STRUCTURE OF REGGE TRAJECTORIES IN THE VENEZIANO MODEL. Kawarabayashi, K.; Kitakado, S.; Yabuki, H. (Kyoto Univ.). Lett. Nuovo Cim.; 1: 564-7(21 Apr 1969).

Further results are reported on the structure of Regge trajectories with abnormal parity. The scattering of 0^- mesons with a nonet 0^+ meson within the framework of the Veneziano model are studied. It is found that the abnormal-parity trajectories should obey a given nonet space rule and a given relation. As a consequence mass formulas are also given. (J.F.P.)

24354 G-PARITY DOUBLET BOSONS AND MASS DEGENERACY. Nakazawa, K. (Dalhousie Univ., Halifax, Nova Scotia). Lett. Nuovo Cim.; 1: 576-80(21 Apr 1969).

It is shown that the G-parity doublet bosons are introduced with a degeneracy in the same manner in case A_1 and A_2. A_1 and A_2 are two minimal extensions by space inversion, A_2 corresponding to the general case and A_1 to an unusual case containing a degeneracy due to P invariance. The respective usual and unusual nature remains unchanged in spite of the unusual property of the abnormal boson. The result is applied to N(1470) and N(1550). (J.F.P.)

24355 USE OF ONE-MESON APPROXIMATION TO DETERMINE $\pi\pi$ INTERACTION CROSS SECTION. Makarov, M. M.; Nelyubin, V. V.; Sarantsev, V. V.; Tkach, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 461-7(Feb 1970). (In Russian).

Elastic $\pi^+\pi^-$-interaction cross sections are determined analyzing the experimental data on the reaction $\pi^-p \to \pi^+\pi^-n$ in the energy range 360-780 MeV. (auth)

24356 MESON TRAJECTORIES. Roos, M. (CERN, Geneva). Lett. Nuovo Cim.; 3: 257-62(19 Feb 1970).

An attempt is made to organize the heavy mesons on a few trajectories or a family of degenerate trajectories based on all recent information available on the heavy mesons. From the properties of the enhancements observed in the U-region, the existence of an $I^{GC} = 1^+$ meson, ρ (2375), is concluded. The confusion of the S and T regions, and notably of the R-region, is well accounted for and classified by the proposed trajectories I, I', II, III, and IV. The particles not accounted for are δ, $\pi_N(1016)$, $\eta_{0^+}(1060)$, A_1, E, F, and $\rho(2100)$. (L.B.S.)

24357 MIXING OF THE η AND η' MESONS AND THE VENEZIANO MODEL. Costa, G. (Univ., Bari, Italy. Istituto Nazionale de Fisica Nucleare, Bari, Italy). Lett. Nuovo Cim.; 3: 329-33(7 Mar 1970).

The problem of the internal symmetry in the Veneziano model is examined assuming the ideal nonet mixing for 1^- and 2^+ mesons and permitting arbitrary mixing between the η and the η'. The considerations are based on asymptotic symmetry requirements which impose, independently of the Alder self-consistency condition, a universal slope for the trajectories in the Veneziano model. The $\pi\pi$, πK, $K\bar{K}$, and also $\pi\eta \to \pi\eta$, $K\pi \to K\eta$, and $K\eta \to K\eta$ interactions are considered. (J.F.P.)

24358 MODEL FOR $\pi\pi$ SCATTERING. Shapiro, Dzh.; Iellin, Dzh. (Univ. of California, Berkeley). Yadern, Fiz.; 11: 443-7 (Feb 1970). (In Russian).

A model for $\pi\pi$ scattering is proposed using functions of the type recently suggested by Veneziano. The resulting threshold phenomena, and also the predicted widths and positions of the $\pi\pi$ resonances are discussed. (auth)

24359 PADE APPROXIMANTS FOR s-WAVE $\pi\pi$ INTERACTION IN STATES WITH I = 0 AND I = 2. Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). Yadern, Fiz.; 11: 457-60 (Feb 1970). (In Russian).

Padé approximants are constructed for the amplitudes of $\pi\pi$ scattering based on the iteration of dispersion relations over the substraction constant. The s-wave $\pi\pi$ interaction in the states with I = 0 and I = 2 is analyzed at low energies and in the subthreshold region. (auth)

24360 K-MESON CONSPIRACY AND THE REACTIONS $p\bar{p} \to \lambda\bar{\lambda}$. Hadjioannou, F. J.; Poulopoulos, P. N. (Athens Univ.). Lett. Nuovo Cim.; 3: 384-8(21 Mar 1970).

A previous large coupling constant is used to calculate the contribution to the cross section of the $K-K_C$ conspirator exchange system. It is found that reasonable conspiracy models can account for 20 to 80% of the experimental cross sections. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstracts 23832, 24254, and 24391.

24361 (JINR-P2-4970) THE EFFECT OF THE ELECTROMAGNETIC STRUCTURE OF HADRONS ON THE VALUE OF THE $\pi^-p \to ne^+e^-$ CROSS SECTION. Tarasov, A. V.; Tkachev, L. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Differential cross section for the process $\pi^-p \to ne^+e^-$ near the 33-resonance is considered. It is shown that this cross section is especially sensitive to the value of the electric proton radius. (auth)

24362 REMARKS ON FINITE-ENERGY SUM RULES. Parke, William C. (George Washington Univ., Washington, D. C.); Ponzini, Robert G.; Williams, H. Thomas. Phys. Rev., D; 1: 134-9 (1 Jan 1970).

Finite-energy sum rules with generalized weight functions are discussed with emphasis on methods for obtaining precise determination of high-energy parameters from low-energy data. Regge parameters for t = 0 πN charge-exchange amplitudes are deduced as an example from a new sum rule. (auth)

24363 NATURE OF SU(3) X SU(3) SYMMETRY BREAKING: RESULTS FROM A SYSTEMATIC TEST OF THE SOFT-MESON THEOREMS. von Hippel, Frank (Stanford Univ., Calif.); Kim, Jae Kwan. Contract AT(30-1)-2752. Phys. Rev., D; 1: 151-64(1 Jan 1970).

A systematic test is made of soft-meson-theorem predictions for both elastic and inelastic pseudoscalar–meson–baryon threshold scattering amplitudes. The predictions are obtained by using an extrapolation procedure developed by Fubini and Furlan and by ourselves. The results give considerable support to a theory of SU(3) × SU(3) symmetry breaking proposed recently by Gell-Mann, Oakes, and Renner, and imply that, in the absence of symmetry breaking, the mass of the $J^P = \frac{1}{2}^+$ baryon octet would be approximately that of the physical nucleon. (auth)

24364 MESON–BARYON SCATTERING IN THE QUARK MODEL. Sastry, C. V.; Misra, S. P. (Regional Engineering Coll., Orissa, India). Phys. Rev., D; 1: 166-9(1 Jan 1970).

Many sum rules for meson–baryon scattering amplitudes are obtained considering the quark-quark and the quark-antiquark amplitudes, for the appropriate meson and baryon states. The main differences from earlier work are that mesons are consistently treated as quark-antiquark pairs and not as elementary fields, and that the usual symmetry representation of the states has been taken into account. Further, the assumption that the real part of the amplitude is dominated by quark-quark forces and the imaginary part by quark-antiquark forces yields sum rules connecting these real and imaginary parts for different processes, in consonance with duality requirements. (auth)

24365 TEST OF DUALITY IN π^+p BACKWARD ANGULAR DISTRIBUTIONS. Crittenden, R. R.; Heinz, R. M.; Lichtenberg, D. B.; Predazzi, E. (Indiana Univ., Bloomington). Phys. Rev., D; 1: 169-75(1 Jan 1970).

A model in which the backward π^+p angular distribution is assumed to arise from a sum of direct-channel resonances is compared with the data at intermediate energies. Many as yet undiscovered resonances are assumed to exist as Regge recurrences of experimentally known resonances. The agreement between the results of the model and experiment is qualitatively quite good at angles near the backward direction for incident pion momenta between 2.2 and 5.0 GeV/c. In particular, the position and the shape of the minimum around $u \simeq -0.2$ $(GeV/c)^2$ in the differential cross section is correctly obtained. Since a similar minimum has previously been obtained in a model with Regge-pole exchange in the crossed channel, the result of the calculation gives support to the concept of duality at intermediate energies. (auth)

24366 ORBITAL-ANGULAR-MOMENTUM STRUCTURE OF THE A_1 MESON. Ballam, J.; Brody, A. D.; Chadwick, G. B.; Guiragossian, Z. G. T.; Johnson, W. B.; Larsen, R. R.; Leith, D. W. G. S.; Moriyasu, K. (Stanford Univ., Calif.). Phys. Rev., D; 1: 94-9(1 Jan 1970).

The orbital angular momentum of the A_1 meson produced from $\pi^-p \to \pi^-\pi^-\pi^+p$ at 16 GeV/c was studied by analyzing the decay angular distributions in the $\rho^0\pi^-$ state. A completely Bose-symmetrized formalism was used to measure the ratio g_1/g_0 of the helicity states of the ρ from the A_1 decay. The value obtained, $|g_1/g_0| = 0.48 \pm 0.13$, indicates a substantial d-wave contribution in the A_1 decay. (auth)

24367 REGGE CLASSIFICATION OF THE CASCADE RESONANCES. Spector, Richard M. (Wayne State Univ., Detroit). Phys. Rev., D; 1: 365-7(1 Jan 1970).

By using a previously developed dispersion technique, the Chew-Frautschi and the Imα-versus-s plots for the cascade resonances are investigated. The eight resonances are found to lie on three nearly linear plots on both graphs as was found to be the case previously for the baryon N_γ and Δ_δ sequences. Of the two types of resonances, probable and doubtful, all of the former are fitted (with no gaps on the trajectories) and none of the latter is needed. Severe self-consistency requirements are well satisfied by the two plots. (auth)

24368 ANALYSIS OF THE πN PARTIAL WAVE. Garg, Ramesh C.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev., D; 1: 360-1(1 Jan 1970).

With the notable exception of the S waves, reasonably good fits to the πN phase-shift analyses have been obtained with a phenomenological one-pole, multichannel ND^{-1} model. It is shown that a two-channel (πN,$\pi\Delta$) model with a second pole in only the diagonal πN potential yields a good fit to the detailed behavior of the S_{31} partial wave. (auth)

24369 PRODUCTION MECHANISM FOR REACTIONS FORBIDDEN IN SINGLE-MESON EXCHANGE. Singh, C. P.; Agarwal, B. K. (Univ. of Allahabad, India). Phys. Rev., D; 1: 363-5 (1 Jan 1970).

Observed angular distributions for the processes $\pi^+ + n \to \pi^- + \Delta^{3+}(1236)$ and $K^- + p \to Y_1^{*-}(1385) + \pi^+$ were explained both in shape and in magnitude using the rescattering model. (auth)

24370 FINITE-ENERGY SUM RULES AND THEIR APPLICATION TO πN SCATTERING AT FIXED u. Kayser, Boris (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev., D; 1: 306-14(1 Jan 1970).

The finite-energy sum rule, and a class of sum rules which can be used to probe the existence of fixed poles, are obtained for amplitudes whose left- and right-hand cuts are not related by crossing symmetry. The finite-energy sum rule is evaluated for each of four independent πN amplitudes with u fixed at $(1236\ MeV)^2$, both sides of the resultant four sum rules being obtained from the properties of the low-energy πN resonances. Results are presented for three choices of end point: $(1356\ MeV)^2$, $(1808\ MeV)^2$, and $(2313\ MeV)^2$. For the intermediate end point, all four sum rules work. For the highest one, however, they all fail. These results, while pointing to a failure of the resonance dominance approximation above 1800 MeV, give us a new confirmation of Regge high-energy behavior on the basis of low-energy data alone. In particular, they verify in some detail the relation predicted by Reggeism between the high-energy, fixed-u behavior of the amplitudes and the low-energy u-channel resonances. They also show that for u = $(1236\ MeV)^2$, all the πN amplitudes have Regge behavior on the

average (duality) above 1800 MeV. The finite-energy sum rules are shown to be violated in a fictitious universe where the lowest particle on each of the leading πN Regge trajectories is accompanied by a degenerate partner of opposite parity. (auth)

24371 REFLECTION MODEL AND HIGH-ENERGY π^-p BACKWARD PEAKS. Li, Ming Chiang (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., D; 1: 326-38(1 Jan 1970).

A classical optical model for high-energy elastic scattering is proposed. The model predicts that the logarithmic slopes for forward differential cross sections should be either the same or twice as large as the backward ones. The backward peak is due to the contribution from the discontinuity in the boundary of the optical medium. The model has the property that the mechanisms responsible for the forward and backward scatterings are not independent of each other. This is contrasted with conventional models which view the forward and backward scatterings as arising from independent mechanisms. For example, in absorptive and Regge-pole models the main contribution to the forward scattering comes from t-channel exchange, while backward scattering arises from u-channel exchange. A fit is made to the high energy π^-p data in both forward and backward directions, and good results are obtained. (auth)

24372 ANALYSIS OF ELASTIC AND INELASTIC PION–NUCLEON SCATTERING USING THE MULTI-CHANNEL ND^{-1} EQUATIONS VIA QUASI TWO-BODY CHANNELS. Garg, Ramesh Chandra. Irvine, Calif.; Univ. of California (1969). 134p.

Thesis.

During the past few years, a lot of data on pion-nucleon scattering has accumulated. Many new inelastic resonances have been discovered which do not conform to the simple Breit–Wigner shape and the number of resonances is increasing very rapidly, the forces involved are not understood. Experimental data on one pion production seem to indicate that this process goes primarily through quasi two body channels, with one of the final two particles decaying strongly. This feature is used to analyze both elastic and inelastic data. Since there has been very little success with dynamical models, a phenomenological three channel ND^{-1} model is used with the left hand cut approximated by a simple pole, the residues of the pole being treated as free parameters to fit the elastic data. The inelastic channels are assumed to be $\pi N \to \pi N^*$ and $\pi N \to \rho N$. The position of the pole is taken at or near the nucleon mass. The production amplitude for the intermediate "Isobar" when multiplied by its decay amplitude gives the amplitude for the process $\pi N \to \pi\pi N$ for which the theory was developed in a relativistic helicity formalism. The phase shifts and inelasticity parameters were calculated for S31, P31, P33 and D33 partial waves for pion laboratory kinetic energies up to 1600 MeV, using only twenty free parameters, while other people use a few hundred parameters to find a set of phase shifts for isotopic spin ½. The fit to S31 is not very good. It is thought that a two pole approximation for the left hand cut is needed to fit S-waves. From the production amplitudes obtained from fitting the elastic data, the momentum distributions of the final three particles in the reaction $\pi^+p \to \pi^+p\pi^0$ at 600, 720, and 810 MeV are then predicted, obtaining a fairly good agreement with the experimental data with no free parameters in the analysis. In the traditional N*(1238) "isobaric" model, it will require at least 24 free parameters to fit the data at these three energies. (Diss. Abstr.)

24373 ENERGY DEPENDENCE OF CROSS SECTIONS FOR INELASTIC COLLISIONS OF HADRONS. Hofmokl, T.; Wroblewski, A. (Univ. of Warsaw). Phys. Lett.; 31B: 391-3(16 Mar 1970).

The energy dependence of the cross sections for inelastic collisions of hadrons is found to be well described by a simple power law: $\sigma^* \propto p_{lab}^n$, where σ^* is the cross section normalized to constant phase space volume available for secondary particles. The value of the exponent, n, is shown to depend on the multiplicity of the interaction. (auth)

24374 EXPERIMENTAL COMPARISON BETWEEN ON- AND OFF-MASS-SHELL INELASTICITY IN π^+p SCATTERING. Colton, Eugene; Schlein, Peter E. (Univ. of California, Los Angeles). Phys. Rev., D; 1: 373-6(1 Jan 1970).

Evidence is presented from a proton–proton bubble-chamber experiment at 6.6-GeV/c beam momentum that the cross-section ratio $\sigma(pp \to \pi^+p\pi^+\pi^-n)/\sigma(pp \to \pi^+pn)$ for low momentum transfer to the neutron ($t<0.2$ GeV^2) is approximately the same as the cross-section ratio $\sigma(\pi^+p \to \pi^+p\pi^+\pi^-)/\sigma(\pi^+p \to \pi^+p)$ when compared as a function of invariant mass of the non-neutron system in the pp reactions. These results imply that (a) pion exchange dominates $pp \to (\pi^+p\pi^+\pi^-)n$ for low momentum transfer to the neutron, in view of the recent results of Ma et al. on $pp \to (\pi^+p)n$, and (b) the off-shell corrections to the pion pole equation for $pp \to (\pi^+p\pi^+\pi^-)n$ are similar to those for $pp \to (\pi^+p)n$; the results presented here complement those presented earlier by Colton et al. for the reactions $pp \to (p\pi^-)\Delta^{++}$, $(p\pi^-\pi^0)\Delta^{++}$, and $(n\pi^-\pi^+)\Delta^{++}$. (auth)

24375 HADRON COUPLINGS IN BROKEN SU(6) X O(3). I. BARYON DECAYS. Katyal, D. L.; Mitra, A. N. (Univ., Delhi). Phys. Rev., D; 1: 338-51(1 Jan 1970).

A new form of parametrization is proposed for meson–baryon couplings in a phenomenological quark (Q) model of broken SU(6) × O(3) for the decays of baryons (mass M) belonging to the representations $(56,2l^+)$ or $[70, (2l+1)^-]$ to baryons (mass m) belonging to 56, together with the emission of pseudoscalar (P) mesons (mass μ). The starting point is the use of the direct term in $\bar{Q}QP$ coupling for the evaluation of the meson–baryon coupling structures which are reexpressed in terms of nonrelativistic Rarita–Schwinger fields together with multiple derivative structures in the meson field. A relativistic generalization of the latter is then proposed through a simple extension of the index structures in the $(L+1)$ partial-wave coupling terms. For the $(L-1)$-wave coupling terms, which appear with an extra multiplying factor k^2 in the meson three-momentum k, an additional ansatz $k^2 \to k_\mu k_\mu$ $(\equiv -\mu^2)$ is used in order to include the contributions of the recoil terms for $(L-1)$-wave transitions in a certain special combination, so as to incorporate the experimental feature of enhanced heavy-meson decays in the s wave. Finally, all these coupling terms are assumed to be multiplied by the following form factor, the plausibility of whose structure is defended on physical grounds: $f_l(k^2) = g_l\mu^{-L-1}(\mu/m_\mu)^{\frac{1}{2}}(\mu/\omega_\mu)^{L+1}(M/m)^{\frac{1}{2}}$, where the exponents $(L \pm 1)$ are used for emissions in the corresponding waves, and g_l is a single free parameter governing the entire supermultiplet transition. The scheme, which is subjected to a detailed experimental test in respect to a large number of baryonic transitions from $(70,1^-)$ and $(56,2^+)$ states involving a wide range of masses and momenta, is found to provide an impressive number and quality of agreements with experiment. It is also shown to yield almost equal values of the coupling constants g_l in respect to the couplings of several Regge recurrences of the Δ resonances, in conformity with the general expectation of a universal coupling for the Regge trajectory of a given particle. (auth)

24376 ASSOCIATED PRODUCTION OF Σ^-K^+ IN THE RESCATTERING MODEL. Saxena, A. B.; Agarwal, B. K.; Singh, C. P. (Univ. of Allahabad, India). Phys. Rev., D; 1: 358-9(1 Jan 1970).

The rescattering model was applied to explain the observed angular distributions at various energies for the process $\pi^-p \to \Sigma^-K^+$. The theoretical calculations are in reasonable agreement with experiments regarding magnitude, shape, and energy dependence. (auth)

24377 CONFIGURATION MIXING IN SU(6) x O(3) FOR THREE-QUARK BARYONS. Nwachuku, C. O. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., D; 1: 315-16(1 Jan 1970).

A configuration mixing of the states $|56, W = \frac{1}{2}, L = 0^+\rangle$ and $|70, W = \frac{1}{2}, L = 1^-\rangle$ in SU(6) ⊗ O(3) is shown to reproduce experiments on G_A, G^*, and $\alpha = d/(d+f)$ more accurately than the $|56, W = \frac{1}{2}, L = 0^+\rangle$ and $|20, W = \frac{1}{2}, L = 1^-\rangle$. This is indeed desirable, since it ties up neatly with the quark model, phase-shift analysis, and experiments—that the $(56,0^+)$ and $(70,1^-)$ are the lowest-lying supermultiplets which accommodate the physical baryons. At the same time, it raises the question of the dynamical origin of representation mixing. (auth)

24378 PERIPHERAL HYPERON AND Y* PRODUCTION IN πp INTERACTIONS AT HIGH ENERGY. Kirz, J. (State Univ. of N. Y., Stony Brook). pp 59-85 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Recent experimental results on peripheral hyperon and Y* production in πp interactions are discussed on the basis of the one meson exchange diagram. The models suggested for the interactions $\pi^+p \to K^+\Sigma^+$, $\pi^+p \to K^0\Delta^0$, $\pi^-p \to K^0\Delta^0$, and $\pi^-p \to K^0\Sigma^0$ are based on the exchange of the Regge trajectories associated with K*(890) and K*(1420). With the added assumption of exchange degeneracy of the two trajectories it leads to the following prediction: pairs of reactions related by the reversal of the K and π lines should have equal differential cross sections. No evidence is found for a peripheral peak in $\pi^-p \to K^+\Sigma^-$. Evidence for a peripheral peak was found for $\pi^-p \to K^+Y^{*-}$. 36 references. (L.B.S.)

24379 HIGH ENERGY COLLISION IN COSMIC RAYS. Koshiba, M. (Tokyo Univ.). pp 161-205 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

A model of high energy inelastic collision characterized by two different components of secondary particles, i.e., the pionization component and the isobar decay component, is substantiated with recent experimental cosmic ray data. 34 references. (L.B.S.)

24380 TWO-BODY EXCHANGE REACTIONS. Sonderegger, P. (CEA, Saclay, France). pp 259-94 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Recent progress in the field of two-body reactions at high energy is described. Results concerning pion exchange reactions rule out the hypothesis of the pion conspiracy, and require instead Regge cuts. The impact of duality is considerable; it greatly simplifies the Regge pole formalism, and leads to encouraging agreement with experiment, provided Regge cuts are included. Regge cuts may contribute to reactions which are forbidden in the one particle exchange approximation; there is virtually no experimental evidence for such forbidden peaks yet. (auth)

24381 DUALITY AND NONET DEGENERACY. Logan, R. K.; Roy, D. P. (Univ. of Toronto). Lett. Nuovo Cim.; 3: 517-20(18 Apr 1970).

It is shown that the postulates for exchange-degenerate trajectories from previous dual-quark diagrams lead to nonet degeneracy. The reactions $\pi^+ + p \to \pi^+ + p$, $\pi^+ + p \to K^+ + \Sigma^+$, and $K^+ + \Sigma^+ \to K^+ + \Sigma^+$ are considered. It is found that the observed breaking of nonet degeneracy seems to suggest a significant breaking of duality in pseudoscalar meson–baryon scattering. (J.F.P.)

24382 REACTION $\pi^- p \to \eta^0 n$ WITH THE ACCOUNT OF MOVING BRANCH POINTS. Sukhorukov, S. T. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 453-6 (Feb 1970). (In Russian).

Experimental data on the reaction $\pi^- p \to \eta^0 n$ are analyzed in terms of the complex momenta method taking into account moving branch points. Good agreement with the experiment in the region of small momentum transfer is obtained. (auth)

24383 BOOTSTRAP DYNAMICS OF PION–NUCLEON SCATTERING. Bessey, William Edward. Cincinnati, Univ. of Cincinnati (1969). 87p.

Thesis.

The low energy pion-nucleon scattering phase shifts are calculated by means of an ND^{-1} dispersion formulation. The method uses the helicity amplitudes and incorporated the exact elastic unitarity condition. The coupled integral equations are solved analytically for a pole input derived from fixed-angle dispersion relations. The fixed-angle method is very tractable and avoids most of the problems inherent in the more usual methods of calculation. The input is composed of the u-channel nucleon and 3-3 resonance exchanges and the t-channel ρ- and ω-exchanges. The calculated results are in good agreement with experimental results. (Diss. Abstr. Int., B)

24384 PARTIAL-WAVE ANALYSIS OF $\pi N \to \pi\pi N$ REACTION IN THE 290 TO 480 MeV ENERGY REGION IN TERMS OF THE MODEL BY OLSSON AND YODH. Kravtsov, A. V. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 387-94 (Feb 1970). (In Russian).

Using the least square method, the parameters of the Olsson and Yodh model are determined for the T_π-energies 290, 338, 360, 430, and 480 MeV. The contributions from resonance (going via the Δ_{33} isobar production) and from nonresonance channel to the reaction $\pi N \to \pi\pi N$, are calculated. The calculated inelastic cross sections in the states P_{11}, D_{13}, P_{31}, and D_{33} coincide with the results of the πN phase-shift analysis. The obtained square ratio of the isotopical amplitudes $A_{\frac{1}{2}}$ and $A_{\frac{3}{2}}$ for the reaction $\pi N \to \pi\Delta$ contradicts the value 10 predicted by $SU(6)_w$. (auth)

24385 INELASTIC HADRON SCATTERING IN THE QUARK MODEL WITH THE FACTORIZATION HYPOTHESIS. Kobushkin, A. P.; Kukhtin, V. V.; Naumov, A. P. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh.; 14: 1879-81(Nov 1969). (In Russian).

The inelastic two-body reactions are investigated on the basis of factorization assumption for the quark amplitudes. The spin structure of the hadron wave functions is taken into account. The obtained relations for differential cross sections are compared with the experimental data. (auth)

24386 CALCULATION OF THE $\Lambda - \Sigma^0$ AND ω-ρ MASS DIFFERENCES. Izmailov, S. V.; Molchatskii, L. S. (Leningrad State Pedagogical Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 65-9(1969). (In Russian).

The Dashen–Frautschi method, standard for the case of new bound-state production in perturbation theory, is used for the numerical estimate of the mass differences of the $\Lambda - \Sigma^0$ and ω–ρ particles. (tr-auth)

24387 EXCHANGE DEGENERACY AND Σ-Λ SPLITTING. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 1: 254-9(1 Jan 1970).

The hypothesis is made that the sum of the imaginary parts of the baryonic Regge contributions to exotic meson-baryon scattering amplitudes must vanish. This hypothesis is combined with the assumptions that all coupling constants satisfy exact SU(3) symmetry and that the Σ-Λ mass splitting cannot be neglected, so that the Σ and Λ lie on different Regge trajectories. All possible partitions of the spin-parity-$\frac{3}{2}^-$ Λ's and Σ's (belonging to an octet, singlet, and decuplet) into the two trajectories are considered. A set of consistency equations is derived, and all solutions are obtained. If the $\Lambda(1520)$ is the only odd-parity hyperon on the bottom [$\Lambda(1115)$] trajectory, and the $\Lambda(1690)$ and one or two Σ's lie on the top trajectory, there is only one solution. In this solution, there is no odd-parity decuplet, the F/D ratios of the couplings to meson-baryon states of the $j_p = \frac{1}{2}^+$ and $\frac{3}{2}^-$ trajectories are 1, and the singlet-octet mixing angle of the $\frac{3}{2}^-$ Λ's is $\theta = \tan^{-1}\sqrt{\frac{1}{2}}$. This solution is in approximate agreement with experiment. (auth)

24388 DO K MESONS VIOLATE THE POMERANCHUK THEOREM. Restignoli, M.; Violini, G. (Univ., Rome). Phys. Lett.; 31B: 533-6(13 Apr 1970).

Recent $K^\pm N$ total cross section data are examined in the framework of the Regge pole model and the effect of possible systematic errors is investigated. No evidence is found for a violation of the Pomeranchuk theorem. (auth)

24389 EVALUATION OF FINITE ENERGY SUM RULES IN NON-FORWARD DIRECTIONS. Bowcock, J. E.; Ng, P. H. (Univ. of Birmingham, Eng.). Phys. Lett.; 31B: 541-3 (13 Apr 1970).

The contribution from the unphysical region to FESR is evaluated for π-N scattering both as a function of t and the order of the moment of the sum rule employed. It is concluded that only for a limited range of t and a restricted set of moments can this be reliably estimated and that as a consequence Regge parameters deduced from FESR are uncertain to a far greater extent than previously supposed. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 23764, 24229, and 24374.

24390 (JINR–E2-5007) MODIFICATION OF THE GLAUBER FORMULA FOR VIOLATION OF THE POMERANCHUK THEOREM. Queen, N. M.; Violini, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 6p. Dep. CFSTI (U. S. Sales Only).

It is pointed out that the usual form of the Glauber formula for total deuteron cross sections breaks down if the Pomeranchuk theorem is violated, and a simple modification of it is derived for this case. Assuming the validity of the Okun-Pomeranchuk theorem, under general conditions the Glauber correction reduces asymptotically to $\delta\sigma = 2\sigma_{el}$, where σ_{el} is the total elastic cross section for scattering by nucleons. (auth)

24391 (JINR–P2-5028) ON THE PROCESSES WITH K-MESON DOUBLE STRANGE EXCHANGE. Lapidus, L. I.; Tarasov, A. V.; Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The process of double strangeness exchange interactions of kaons with nuclei is discussed. The final states in K^--^{4}He interactions are presented with proper thresholds and hypernuclei which can be produced. Possible kaon double strange exchange processes on deuterons are presented. The deviation of the cross section is considered on the Glauber approximation. Estimates are given for the double strangeness exchange cross sections on nucleons and on deuterons. (L.B.S.)

24392 INELASTIC EFFECTS IN HIGH-ENERGY PION–DEUTERON SCATTERING IN A COMPOSITE MODEL. Harrington, David R. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 1: 260-6(1 Jan 1970).

Inelastic effects in high-energy pion-deuteron scattering are investigated using a model in which the pion is a two-particle composite system. The inelastic pion form factors required in calculating inelastic pion-nucleon scattering are related to the elastic form factor by assuming that the low-lying states of the pion system are identical with the corresponding states of a nonrelativistic isotropic harmonic oscillator. In the model, pion-deuteron scattering can be viewed in two ways which are shown to be completely equivalent: as the scattering of two two-particle composites, or as pion-deuteron scattering in which excited pions can occur in intermediate states. Inelastic contributions are found to be negligible near the forward direction, but important at large angles. Including corrections from the lowest-lying excited states of the pion considerably improve the accuracy of the calculations at intermediate angles. (auth)

24393 THREE-DIMENSIONAL BETHE-SALPETER EQUATION APPLIED TO THE NUCLEON-NUCLEON INTERACTION. Thompson, Richard H. (Univ. of Florida, Gainesville). Phys. Rev., D; 1: 110-17(1 Jan 1970).

A tractable, relativistic theory for the two-nucleon system is constructed. As a starting point, the Bethe-Salpeter (BS) equation is utilized. In order to reduce the BS equation to three dimensions, the Blankenbecler-Sugar method is generalized to include spin-½ particles. An instantaneous-interaction approximation to the BS equation is also investigated, and results similar to those obtained with the Blankenbecler-Sugar method are derived. Finally, as an application, the generalized potential or interaction kernel is approximated to order g^2 and compared to the one-pion-exchange potential (OPEP) used in conjunction with the Schrödinger equation. The singlet states are treated numerically, and results are presented which show that for a lab kinetic energy of 400 MeV, the phase shifts calculated from the relativistic theory differ from those calculated by solving the Lippmann-Schwinger or Schrödinger equation with OPEP by about 20%. (auth)

24394 DEUTERON CONSTRAINTS ON LOW-ENERGY NUCLEON-NUCLEON SCATTERING ANALYSES. Arndt, Richard A.; Roper, L. David (Virginia Polytechnic Inst., Blacksburg). Phys. Rev., D; 1: 129-40(1 Jan 1970).

A determination is made of the constraints which are imposed upon the low-energy $^3S_1$-$^3D_1$ scattering parameters in order that the S matrix may satisfy the known static deuteron properties. A multichannel effective-range representation is used to derive a relationship between the phase parameters δ_S, δ_D, and ϵ_1 at "low" energies. The relationship is violated by all of the present low-energy phenomenological determinations. This indicates a discrepancy between the existing low-energy np scattering data and the static deuteron properties, and suggests that low-energy energy-dependent phenomenology should manifestly contain the deuteron constraints. (auth)

24395 THEORY OF DOUBLE CHARGE-EXCHANGE SCATTERING OF PIONS FROM ^{3}He AT HIGH ENERGIES. Rudin, Robert Alfred. New Brunswick, N. J.; Rutgers-The State Univ. (1969). 87p.

Thesis.

The quasi-elastic differential cross section for the double charge exchange reaction $\pi^-He^3 \rightarrow \pi^+3n$ at 10.8 BeV/c is calculated using Glauber's eikonal approximation. At first, spin-dependence is ignored and an empirical parametrization of the charge exchange amplitude is used. Several nuclear wave functions are compared, all of which give nearly identical results, provided their parameters are chosen to fit the experimental electromagnetic form factors. An uncorrelated ground state nucleon density with parameters determined from electron scattering experiments gives similar results. The total cross section is estimated, and some frequently-made assumptions are examined. Spin-dependence is then introduced by means of a Regge-pole parametrization of the charge exchange amplitude on the assumption of ρ-exchange. Results are compared with the spin-independent calculation, and a complete spin analysis is presented. The theory is extended to inelastic processes, and inelastic contributions to the reactions $\pi^-d \rightarrow \pi^-d$ and $\pi^-He^3 \rightarrow \pi^+3n$ are calculated. (Diss. Abstr.)

24396 DEVIATIONS FROM CHARGE INDEPENDENCE IN NUCLEAR FORCES. El-Ghabaty, Sayed S. (Wayne State Univ., Detroit); Gupta, Suraj N.; Kaskas, James. Phys. Rev., D; 1: 249-53(1 Jan 1970).

A simple mass-averaging device is described for the investigation of the effect of the pion mass difference on the nucleon-nucleon interaction. While the mass-difference correction in the one-pion-exchange contribution is known to be significant, it is found that the corresponding correction plays a less significant role in the two-pion-exchange contribution. The effect of difference in the pion coupling constants is also discussed, and found to be equally significant in the one- and two-pion-exchange contributions. The applicability of our approach to the ρ-exchange contribution is pointed out. (auth)

24397 REGGE-POLE EIKONAL THEORY OF SMALL-ANGLE PION-^{3}He AND KAON-^{3}He SCATTERING. Arnold, Richard C. (Argonne National Lab., Ill.); Vossler, Charles. Phys. Rev., D; 1: 188-91(1 Jan 1970).

The scattering of π's and K's from a ^{3}He nucleus was calculated using the Regge-eikonal model proposed by Arnold, Blackmon, and Goldstein. A phonomenological form factor is used to relate the Regge amplitude for scattering from a weakly bound composite system to the scattering from the components of the system. In this way qualitative features of the elastic and charge-exchange differential cross sections and polarizations for $\pi^{\pm}$-^{3}He and $K^{\pm}$-^{3}He processes are predicted. (auth)

24398 MODEL FOR LOW-ENERGY PROPERTIES OF THREE-NUCLEON SYSTEM. Brayshaw, D. D.; Buck, B. (Columbia Univ., New York). Phys. Rev. Lett.; 24: 733-6(30 Mar 1970).

Calculations are presented for the properties of the three-nucleon system below the three-body breakup threshold, using simple, static, central potentials which fit the s-wave scattering lengths and effective ranges for nucleon-nucleon scattering. (auth)

24399 EFFECT OF THE MOTT-SCHWINGER INTERACTION ON NEUTRON-PROTON SCATTERING. Hogan, W. S. (Battelle-Columbus Labs., Columbus, Ohio); Seyler, R. G. Phys. Rev., C; 1: 17-28(Jan 1970).

The influence of the interaction between the magnetic moment of a neutron and the Coulomb field of a target proton is investigated. For this interaction, channel spin is not conserved. A formalism is developed which includes the resulting singlet-triplet mixing. The scattering amplitude, or M matrix, is presented, and its elements are related to the coefficients of the most general form of the M matrix. Expressions for the nine most common nucleon-nucleon-scattering observables are obtained, including the effects of the singlet-triplet mixing. Coupled radial wave equations are derived and solved to reveal the phase-shift modifications. Calculations are performed over an energy range from 25 to 210 MeV using nuclear phase shifts previously determined from best χ^2 fits to the scattering data. The calculations indicate that all nine of the scattering observables considered are significantly influenced by the Mott-Schwinger interaction, but only for very small (<5°) scattering angles. (auth)

24400 BREMSSTRAHLUNG MODEL FOR PROTON-PROTON ELASTIC SCATTERING AT HIGH ENERGIES. Gemmel, H.; Kastrup, H. A. (Univ., Munich). pp 231-5 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

Elastic proton-proton scattering at high energy is analyzed in the framework of a bremsstrahlung model, and the resulting cross section as a function of the invariant momentum transfer squared is compared with experiment. (L.B.S.)

24401 DETERMINATION OF OVERLAP FUNCTION FROM ELASTIC PROTON-PROTON SCATTERING. Andreev, I. V.; Dremin, I. M.; Shteinberg, D. N. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 11: 468-71(Feb 1970). (In Russian).

The behavior of the overlap function outside the diffraction cone is considered. It is shown how the elastic scattering near the diffraction cone ($1 \lesssim t \lesssim 6$ (GeV/c)^2) may provide information about change of the Gaussian angular dependence characteristic for the overlap function at small angles. Numerical calculation of the overlap function based on the experimental data about elastic pp scattering at energies 10.8 and 19.2 GeV, is performed. (auth)

24402 POLARIZATION PHENOMENA IN ELASTIC SCATTERING ON DEUTERONS IN THE GLAUBER APPROACH. Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 382-6(Feb 1970). (In Russian).

Polarization effects in high energy elastic πd(Kd,Nd) scattering are considered. A possibility is noted to detect experimentally what mechanism among those discussed previously in connection with the "filling the dip" in the differential cross section plays the main role at $t = t_0$. (auth)

24403 MULTIPLICITY DISTRIBUTION IN pp INELASTIC COLLISIONS. Chow, G. Y. (Saginaw Valley Coll., University Center, Mich.). Lett. Nuovo Cim.; 3: 545-9(18 Apr 1970).

Starting from a Poisson distribution for the number of produced pions the multiplicity distribution of pp inelastic interactions is investigated. A point to point comparison with previous predictions is made, and also comparison is made with a multiperipheral bootstrap model predictions. (J.F.P.)

24404 SECONDARY PARTICLE PRODUCTION ACCORDING TO THE THERMODYNAMICAL MODEL AND NEW EXPERIMENTAL DATA. Ranft, J. (Karl-Marx-Univ., Leipzig). Phys. Lett.; 31B: 529-32(13 Apr 1970).

A comparison of the thermodynamical model for multiparticle particle production with new experimental data is reported. Particle yields measured at $P_0 = 19.2$ GeV/c and 70 GeV/c are first used to correct the behavior of the thermodynamical model near the kinematical limits. The resulting predictions of the model agree well with new experimental data at 12.5, 35, 43, 52, and 70 GeV/c. (auth)

24405 SOME NUCLEAR ASPECTS OF LAMBDA-HYPERNUCLEAR PHYSICS. Dalitz, R. H. (Oxford Univ.). pp 701-87 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

The treatment of some aspects of Λ hypernuclear physics covers the stability of hyperons in nuclei, properties of free Λ decay, the systematics and spin determination for Λ hypernuclei, the well depth for heavy hypernuclei, and the formation of Λ hypernuclei. Also treated are Λ + p scattering at low energies, theory for ΛN forces, B_Λ analysis for s-shell hypernuclei and the discrepancy with the p scattering data. The ΛNN interaction and the s shell hypernuclei, B_Λ values for the p-shell hypernuclei, and the Λ particle in nuclear matter are included. (J.F.P.)

24406 S-WAVE π PRODUCTION IN NUCLEON–NUCLEON COLLISIONS: FINITE-MASS CORRECTIONS. Young, J. E. (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.); 56: 391-429(Feb 1970).

The finite-mass corrections to previously obtained zero-mass, threshold, π-production cross sections in NN-collisions are presented. The corrections in question amount to about 8% for the unbound production process (e.g., $p + p \rightarrow \pi^+ + n + p$) in I = 1 states, which is all that is discussed. The technique employed is a combination of the use of spurions and the Fubini-Furlan mass-dispersion method. (auth)

Particle Invariance Principles and Symmetries

General

24407 SATURATION OF A CHIRAL CHARGE–CURRENT COMMUTATOR WITH REPRESENTATIONS OF $SU(6)_{p3} \times O(3)$. Tjia, May On. Evanston, Ill.; Northwestern Univ. (1969). 133p. Thesis.

The saturation of the charge–current equal-time commutation relation, $[F^k_\alpha(x_0), J^k_{\beta O}(x)] = if_{\alpha\beta\gamma}J_{\gamma O}(x)$, in the infinite-momentum frame is studied. Detailed investigations are conducted by employing specific saturation schemes associated with a pure $SU(6)_{p3}$ representation space as well as a mixed configuration of $SU(6)_{p3} \otimes O(3)$. In particular, the consistency of such finite saturation schemes for the above commutator are examined. In comparison with the corresponding charge–charge commutator in the chiral $SU(3) \otimes SU(3)$ algebra. The study reveals, as expected, that the consistency requirement can not be fulfilled over the entire range of the momentum-transfer q. It is also discovered that the symmetric and antisymmetric combinations of the above commutator display different degrees of contradiction: the former admits only a zero "range of consistency," while the latter yields a family of sum rules near q = 0. These sum rules obtained for the antisymmetric case with the $SU(6)_{p3} \otimes O(3)$ representation-mixing scheme mentioned above, contain predictions for the zero-q^2 intercepts and slopes of the form factors involved. Among the values predicted for these parameters the disturbing results, $\mu'(p) = \mu'(n) = 0$ and $\mu^*(N^*) = 0$ are found along with many others yet to be tested experimentally. Investigation also demonstrates that as far as the consistency of the saturation scheme is concerned, even a substantial extension of the scheme fails to induce any visible improvement. While the sum rules, by and large, appear to respond to such a mixing procedure, many of the results remain unaffected including the critical ones stated earlier. It is also noted that the CVC hypothesis plays a minor role in the work. A closer investigation of these problems suggests the desirability of considering modified transformation properties for the local current operators. Along these lines, a new set of algebraic relations are abstracted from a simple model. These relations are shown to offer some hope for improved results deduced in the framework of a finite saturation scheme. A further study of this proposal is warranted. (Diss. Abstr.)

24408 THE FINITE TRANSFORMATIONS OF THE GROUP SU(3). Majumdar, S. Datta; Basu, Biplab Kumar (Indian Inst. of Tech., Kharagpur). Ann. Phys. (N. Y.); 56: 464-73(Feb 1970).

Representations of finite transformations of the group SU(3) are obtained by breaking up the elements into simpler factors. Some of the factors belong to the fully reduced SU(2) subgroup and are represented by ordinary rotation matrices. Amongst the other factors there are two numerical matrices, $(1 \pm i\sigma_2)$. Representations of these are obtained by subjecting the variables of a basic state to the appropriate transformation and expanding the function so obtained in a series of the basic states. The expansion coefficients involve generalized hypergeometric series of the ${}_4F_3(1)$ type which are shown to be multiples of 6-j symbols. (auth)

24409 SEMISTRETCHED AND FUNDAMENTAL ISOSCALAR FACTORS OF SU_3. Alishauskas, S. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 641-53(1969). (In Russian).

Expressions for isoscalar factors having only two summation parameters for all multiplicity free cases of reduction of direct product of two representations of group SU_3 are obtained. Recursion formulas, methods of summation of quantities of representations of SU_2 and substitution group are used. Expressions for some of recoupling matrices of SU_3 are given. (auth)

Applications (Electromagnetic and Weak)

24410 CABIBBO ANGLE AND 27-PLET DRIVING TERMS. Bane, J. C.; Mahanthappa, K. T. (Univ. of Colorado, Boulder). Phys. Lett.; 31B: 271-3(16 Mar 1970).

It is shown that a modification of the equations $y_i - \sqrt{3}\, d_{ijk}y_jy_k = g_i$ to include 27-plet driving terms contained in second order electromagnetic and nonleptonic part of current–current interactions leads to a discrete nonzero value for the Cabibbo angle. (auth)

24411 ELECTROMAGNETIC CONTRIBUTIONS TO THE CHARGE ASYMMETRY IN THE SEMILEPTONIC DECAYS OF NEUTRAL KAONS. Ryan, C. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., D; 1: 299-314(1 Jan 1970).

While the measured charge asymmetry in the semileptonic decays of K^0_{l4} is clear-cut evidence for CP violation in these processes, the detailed theoretical interpretation of this result is somewhat complicated by the presence of electromagnetic effects. It is shown, however, that whereas these electromagnetic effects can produce sizable differences in decay distributions for decays into charge-conjugate states, their contribution to the asymmetry parameter δ^π_L is not greater than $\alpha\Gamma(K^0_{l4})/\Gamma(K^0_{l3})$. (auth)

24412 T-VIOLATION EFFECTS AND FINAL-STATE INTERACTIONS. II. PHOTOPRODUCTION, ELECTROPRODUCTION, AND NEUTRINO-INDUCED PRODUCTION OF A SINGLE PION. Cannata, F. (Univ., Bologna); Leonardi, R.; Strocchi, F. Phys. Rev., D; 1: 191-9(1 Jan 1970).

The results of a previous paper are specialized to photoproduction, electroproduction, and neutrino-induced production of a single pion. A detailed analysis is given of possible T-violation effects. In particular, the problem of eliminating spurious effects arising from final-state interactions is studied, and suitable prescriptions are given for eliminating these spurious effects. Detailed estimations are given of T-violation effects in the various cases and under different kinematical situations. In particular, the interplay of the various multipole transitions is discussed and numerically estimated. The electroproduction of a single pion near threshold and the neutrino-induced production of a single pion appear particularly interesting. (auth)

24413 ELECTROMAGNETIC FINAL-STATE INTERACTIONS AND TESTS OF TIME-REVERSAL INVARIANCE IN NUCLEAR BETA DECAY. Brodine, John C. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 1: 100-6(1 Jan 1970).

Expressions are given for the electromagnetic final-state interaction contribution to D, the triple-product correlation coefficient, in the nuclear β-decay transitions $\frac{1}{2}^- \rightarrow \frac{1}{2}^+$, $\frac{3}{2}^- \rightarrow \frac{3}{2}^+$, $\frac{3}{2}^+ \rightarrow \frac{1}{2}^+$, $\frac{3}{2}^+ \rightarrow \frac{3}{2}^+$, and $1^+ \rightarrow 0^+$ to all orders of $Z\alpha/v_e$ in the Coulomb interaction. (auth)

24414 DIFFERENT CHARGE ASYMMETRIES IN $K_L \rightarrow \pi e\nu$ AND $K_L \rightarrow \pi\mu\nu$ AND CPT VIOLATION. Achiman, Y. (Tel Aviv Univ., Israel). Lett. Nuovo Cim.; 1: 608-11(21 Apr 1969).

A sensitive test of CPT is proposed which can be performed in principle in one experiment. This test is to search for a difference of charge asymmetries of $K_2 \rightarrow \pi + \mu(e) + \nu$ decays. The expressions for the charge asymmetries are explicitly calculated assuming small CPT violation. Using these it is shown that even a very small $e - \mu$ asymmetry may be enhanced considerably in the case of violation of CPT in such a way as to lead to a substantial difference between these two expressions. (J.F.P.)

24415 THE CASE OF Im ($\Delta S = -\Delta Q$) AS THE ONLY SOURCE OF CP VIOLATION. Buchanan, C. D. (Univ. of California, Los Angeles). Lett. Nuovo Cim.; 3: 529-34(18 Apr 1970).

It is shown that previous fragmentary evidence for a $\Delta S = -\Delta Q$ amplitude have a high degree of internal consistency suggesting a nonzero value of Im X, where X = amplitude ($\Delta S = -\Delta Q$)/amplitude ($\Delta S = +\Delta Q$). It is also shown that a model of $K^0_2 \rightarrow 2\pi$ phenomenology in good agreement with experiment can be constructed assuming this value of Im X as the only source of CP violation. (J.F.P.)

24416 EVIDENCE FOR CURRENT DIVERGENCES BELONGING TO THE (3,3*) + (3*,3) REPRESENTATION OF SU(3) x SU(3). Riazuddin; Fayyazuddin (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., D; 1: 282-3(1 Jan 1970).

Evidence is presented that current divergences belong to the (3,3*) + (3*,3) representation of SU(3) × SU(3). Various estimates of the parameter c are given that describe the strength of the

SU(3)-breaking term relative to the chiral-symmetry-breaking term, using the Veneziano model for π-π and π-K scattering. The ratio f_K/f_π is also estimated. (auth)

Applications (Strong)

Refer also to abstracts 24351, 24375, and 24377.

24417 AXIAL COUPLINGS FROM AN APPROXIMATE METHOD BASED ON CHIRAL $SU_3 \times SU_3$. Buccella, F. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); Celeghini, E.; Sorace, E. Lett. Nuovo Cim.; 1: 558-63(21 Apr 1969).

An approximate method based on chiral SU(3) × SU(3) is applied to give constraints for the axial couplings of the baryon octet, which are connected through PCAC to the meson–baryon scattering. The representations (70 L = 1) and (56 L = 2,4) are considered. Two $J = \frac{1}{2}$, $I = \frac{1}{2}$ resonances are classified according to a consistency argument for the second-order corrections to the couplings of the axial charges. (J.F.P.)

24418 SPONTANEOUS BREAKDOWN OF $SU_3 \times SU_3$ TO U_3. Honerkamp, J. (Univ., Bonn). Nuovo Cim.; 66A: 767-88(21 Apr 1970).

A nonlinear realization of $SU_3 \times SU_3$, by which the $\varkappa$-mesons are treated as further Goldstone bosons, is analyzed in more detail. Terms which break the $SU_3 \times SU_3$ invariance are added to the invariant Lagrangian. Relations between masses and decay constants of the Goldstone bosons emerge by which the question of the $\varkappa$ mass is discussed. The K_{l3} form factors are calculated. A modification of the model is given in which $U_2 \times U_2$ rather than SU_3 is regarded as the dominating subsymmetry. Mass relations and form factors are not changed by this modification, but the physical significance of the breaking parameters becomes more transparent. (auth)

24419 DOES CHIRAL SYMMETRY IMPLY PARITY-DOUBLED STATES. Solomon, A. I. (Tel Aviv Univ., Israel). Nuovo Cim.; 66A: 708-12(21 Apr 1970).

It is proposed that a spontaneously broken symmetry is recovered in the high-energy limit. (auth)

24420 SYMMETRY PROPERTIES OF DUAL TREE-GRAPH N-POINT AMPLITUDES. Plahte, E. (CERN, Geneva). Nuovo Cim.; 66A: 713-33(21 Apr 1970).

The dual tree-graph N-point functions are investigated from the point of view of symmetry properties. Using a cyclic symmetric-contour integral for B_N, a set of simple relations is deduced between $N-1$ B_N-functions and rules are given for writing down more complicated relations. Secondly, a new relation between the cyclic symmetric integral and the conventional "multiperipheral" integral for B_N is established. Finally, both approaches are used to investigate the signature properties of B_N. auth)

Field Theories

General

24421 SECOND NOETHER THEOREM FOR LOCAL FIELD THEORIES. Oliveira, Colber G.; Vidal, Alberto (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). An. Acad. Brasil. Cienc.; 41: 309-24(Sep 1969).

The invariance properties of localized fields under transformation groups involving arbitrary functions are studied from the point of view of the action principle. Such invariance implies the existence of a set of identities at each space-time point where the field is defined. These identities can be used as selection rules for the determination of the Lagrangian density of the field. It is shown that the invariant Lagrangian density for a coupled-field is defined in a local affine connected space (the space where the interaction takes place) with a greater number of dimensions than the usual Minkowski space. (auth)

24422 GENERALIZED GOLDBERG–SACHS THEOREM. Misra, M. (Inst. for Advanced Studies, Dublin). Lett. Nuovo Cim.; 1: 615-16(21 Apr 1969).

The difference in two previous results on the generalized Goldberg–Sachs theorem is shown to lie elsewhere than in stronger field equations as previously suggested. It is shown that the two sets of field equations used are identical. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 24200, 24444, 24445, and 24449.

24423 THE LIMIT m = 0 IN TWO THEORIES OF PARTICLES WITH SPIN $S = \frac{3}{2}$. Cukierda, T. (Univ. of Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 17: 581-5(1969).

Using the tensor-spinors representations of the Lorentz group two equivalent theories of the particles with mass m and spin $S = \frac{3}{2}$ are given. It is shown that these theories are inequivalent for the case m = 0 and describe two massless particles with the helicity $H = \pm\frac{3}{2}$ and $H = \pm\frac{1}{2}$. For m = 0 the gauge transformations are explicitly given, and the field equations are shown to be invariant. These gauge transformations are different for both theories. It is also shown that the physical states of the massless particles do not depend on the gauge transformations. (auth)

24424 STATUS OF QUANTUM ELECTRODYNAMICS. Brodsky, S. J. (Stanford Linear Accelerator Center, Calif.). pp 3-20 of Proceedings of the 4th International Symposium on Electron and Photon Interactions at High Energies, Liverpool, September 14th–20th, 1969. /Braben, D. W. (ed.). Liverpool; Daresbury Nuclear Physics Laboratory (1969).

See CONF-690947.

A review is presented under the following headings: Introduction; high energy tests of quantum electrodynamics (electron–positron and electron–electron elastic scattering; Bethe–Heitler pair production and bremsstrahlung; tridents-pair production by leptons; high energy tests of electron–muon university; future high energy experiments); low energy tests of electrodynamics (determination of fine structure constant; fine structure in hydrogen; the Lamb-shift ($2S_{\frac{1}{2}}$-$2P_{\frac{1}{2}}$); theory of the hydrogenic atom; muonic hydrogen; the hyperfine splitting); the anomalous moments (the electron moment; the muon moment); quantum electrodynamics as a model for hadron physics; future progress. (144 references) (UK)

24425 ELECTROMAGNETISM AND QUANTUM THEORY. Grimes, Dale M. Electrical Science, A Series of Monographs and Texts. New York; Academic Press Inc. (1969). 166p. $9.00.

A view of quantum theory on the basis of electromagnetic field theory is presented. Equations of special relativity are developed from a single viewpoint. From these equations classical mechanics and electrodynamics are obtained, and from these are derived the equations of quantum theory. The effects of reactive electromagnetic fields about accelerating charges are included. (J.F.P.)

24426 QUANTUM ELECTRODYNAMICS FOR STRONG FIELDS AND SUPERHEAVY NUCLEI. Reinhard, P.-G. (Univ., Frankfurt am Main). Lett. Nuovo Cim.; 3: 313-18(7 Mar 1970).

Quasi-stable islands of superheavy nuclei are used to study problems in quantum electrodynamics. Starting with the electron field and a complete set of spinor functions the ground state and the 1-electron or 1-positron spectrum of the electron–photon field in a strong external central field is considered. (J.F.P.)

24427 COMPLEX LEE–WICK POLES AS CDD GHOSTS. Lukierski, J. (CERN, Geneva). Nuovo Cim.; 66A: 807-14 (21 Apr 1970).

The Zachariasen–Thirring model with intermediate unstable elementary objects, described by a pair of complex conjugate poles with complex conjugate residues, is solved. It is shown that the replacement of the stable intermediate particle by the above-mentioned pair of complex poles is equivalent to the introduction of a CDD ghost. Also, a modified renormalized solution is given leading to Lee–Wick regularization of the intermediate-stable-particle propagator. (auth)

24428 PADE METHOD IN SINGULAR POTENTIALS. Garibotti, C. R.; Pellicoro, M. F.; Villani, M. (Univ., Bari, Italy). Nuovo Cim.; 66A: 749-66(21 Apr 1970).

As a test of the possibility of using the Padé method in unrenormalizable field theories it was applied to singular potentials. The potential was regularized using a cutoff ϵ, showing that when the cutoff and the order N of the approximant are connected appropriately a fast convergent sequence of approximants is obtained. The connection between ϵ and N is directly provided by the properties of the method and does not depend on the kind of potential considered. The approximants to the scattering length for some typical singular potentials are calculated using this approach. Furthermore, the results show the convenience of using the Padé method to sum asymptotic series. (auth)

24429 ANALYTICITY AND DIPOLE REGULARIZATION. Duerr, H. P.; Seiler, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 66A: 734-48(21 Apr 1970).

It is demonstrated that the modified integration prescription given earlier for the elimination of unphysical asymptotic states in case of a theory with dipole regularization is equivalent to the Lee–Wick integration prescription for poles with complex mass if the dipole is considered as a limiting case of two merging poles, or more precisely, of two merging dipoles with complex conjugate

mass. In particular, the thresholds of unphysical processes becomes points of nonanalyticity in the sense that the function left and right of these points cannot be connected by analytic continuation. The smoothness of this function at the nonanalytic points in the physical region essentially determines the falloff of "acausal" precursors. It appears that with this procedure even ghost poles below the threshold of the continuum do not lead to a violation of unitarity. (auth)

24430 TRANSITION FROM A CONTINUOUS TO A DISCRETE SPACE–TIME SCHEME. Cole, E. A. B. (Univ. of Leeds, Eng.). Nuovo Cim.; 66A: 645-56(21 Apr 1970).

A discrete space and time description of physical events is considered. This involves transforming partial differentials with respect to space and time into finite differences evaluated between neighboring space-time points. By considering a set of such finite-difference forms of the Euler equations for classical fields, a rule for such a transformation is obtained. It is found that each partial differential must be replaced by the corresponding central difference. Energy and momentum eigenvalues are found for particles moving in one dimension along which the separation between adjacent space points is ξ. It is found that these quantities have maximum values proportional to ξ^{-2} and ξ^{-1} respectively, and that there are finite numbers of distinct eigenvalues of each sort. The Schroedinger equation is transformed into a difference equation and is solved formally to give the S-matrix. It is found that the wave function does not tend to a limit at infinite times. (auth)

24431 ON THE FEYNMAN–GELL-MANN EQUATION. Gallone, Franco (Univ., Milan). Ann. Phys. (N. Y.); 57: 65-78 (Mar 1970).

The Feynman–Gell-Mann equation is reduced to the form of an invariant Gel'fand equation for spin one-half. A Lagrangian theory from which this equation may be derived is proposed. It is shown that a Feynman–Gell-Mann equation for charge –e is transformed by space inversion into the complex conjugate of the same equation for charge +e. Both unitary and antiunitary time inversion transformation laws are found. In this formulation charge conjugation is equivalent to complex conjugation and the request of full Lorentz invariance and of a Lagrangian density for the Feynman–Gell-Mann equation leads to recover the second order Dirac equation. (auth)

24432 PLANE-WAVE SPINORS AND FREE FIELDS FOR ZERO-MASS PARTICLES. Meder, L. F. (Univ. of Craiova, Rumania). Ann. Phys. (N. Y.); 57: 1-19(Mar. 1970).

Irreducible local and locally covariant fields for free zero-mass particles are all constructed. Properties of the plane-wave spinors are studied and several equations satisfied by the field operators $\varphi^{s}(x)$ are obtained. Inversion properties of the field operators are established. For purely neutral particles a "self-adjointness condition" on the field operator is deduced. The formalism developed shows a close analogy with the field description of free massive particles except for a number of field equations and connections between intrinsic parities of the particle-antiparticle pair. (auth)

Gravitation and General Relativity

24433 GRAVITATIONAL MOTIONS IN GENERAL RELATIVITY. THE SCALE-FUNCTION. McVittie, G. C.; Stabell, Rolf (Univ. of Illinois Observatory, Urbana). Ann. Inst. Henri Poincare, Sect. A; 9: 371-93(1968).

The radial motions of a spherically symmetric mass under the influence of gravitation and its pressure-gradient are investigated. Solutions of Einstein's equations for the interior of the mass distribution can be subdivided into four different classes. Detailed analysis of the scale-function S is performed for three of these classes. Possibilities of expansion, contraction (collapse) and oscillations are found in all three cases. (auth)

24434 NONRADIATIVE GRAVITATION FIELD STRUCTURE, WITHOUT THE SYMMETRY HYPOTHESIS, IN GENERAL RELATIVITY. Moret-Bailly, I. (CNRS, Paris). Ann. Inst. Henri Poincare, Sect. A; 9: 395-9(1968). (In French).

Two theorems of the "nonradiative" case of a gravitational field without the hypothesis of axial symmetry studied by Sachs are established. Two similar theorems have already been proven for the "nonradiative" field with axial symmetry and, in special relativity, for the electromagnetic field. For the structure of the "nonradiative" field given by the first theorem one deduces the structure of the Bondi-Metzner-Sachs transformations for this field. Further, for the case of a field, which is not necessarily "nonradiative," the existence of transformations is shown more general than those of Bondi-Metzner-Sachs in the sense that they conserve an asymptotic behavior of the field, which includes as a particular case the Minkowski asymptotic behaviour. (auth)

24435 EFFECTIVE POTENTIAL FOR EVEN-PARITY REGGE–WHEELER GRAVITATIONAL PERTURBATION EQUATIONS. Zerilli, Frank J. (Univ. of North Carolina, Chapel Hill). Phys. Rev. Lett.; 24: 737-8(30 Mar 1970).

The Schrödinger-type equation for odd-parity perturbations on a background geometry is extended to the even-parity perturbations. This should greatly simplify the analysis for calculations of gravitational radiation from stars and from objects falling into black holes. (auth)

24436 CONSTANCY OF INERTIAL MASS IN A CENTRIFUGAL FIELD. Beams, J. W. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 24: 840-3(13 Apr 1970).

A search was made for a possible variation in the inertial mass of platinum with respect to that of magnesium produced by the application of a centrifugal field. No variation was found within an experimental uncertainty of 4 parts in 10^5 due to the application of a centrifugal field of 1.5×10^5g or within 3 parts in 10^{10} per g. (auth)

24437 EQUATIONS OF STATE OF CONTINUOUS MATTER IN GENERAL REALATIVITY. Oldroyd, J. G. (Univ. of Liverpool). Proc. Roy. Soc. (London), Ser. A; 316: 1-28(Mar 1970).

The invariant forms that equations of state of continuous matter may take in general relativity, when the rheological behavior of matter at any event may depend on previous rheological states through which that matter has passed, are discussed. A complete set of variables, needed in the general case to specify the relevant information about the matter at event x^i, is first obtained as a set of space-tensors and then as a set of four-tensors orthogonal to the four-velocity at x^i. These variables represent proper measures of deformation history, mechanical-stress history, temperature history, proper-time lag and physical constants of the material. An unambiguous definition is given of a physical constant (tensor) of the material. Elasticity, viscosity, and all possible combinations of these properties are within the scope of the theory. (auth) (UK)

24438 ON A ROBINSON–TRAUTMAN SOLUTION OF EINSTEIN'S EQUATIONS. Bonnor, W. B. (London Univ.). Phys. Lett.; 31A: 269(9 Mar 1970).

Robinson and Trautman proposed a certain metric to represent a null particle. In this letter a different interpretation of the metric is given. (auth)

24439 SOME ASPECTS OF THE SOURCE DESCRIPTION OF GRAVITATION. Radkowski, Alfred Franz (Seton Hall Univ., South Orange, N. J.). Ann. Phys. (N. Y.); 56: 319-54(Feb 1970).

Contributions are made to the source description of gravitation due to Schwinger by developing the necessary gravitational modifications of the couplings of various boson fields to their sources and by providing a numerical supplement to his qualitative discussion of two-particle exchange. (auth)

Scattering Theory

Refer also to abstracts 24342, 24428, and 24636.

24440 (ITF–69–76) LECTURES ON SCATTERING THEORY. I. Sitenko, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 49p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The bases of non-relativistic theory of potential scattering are presented in the lectures. The presentation is based on the introduction of the scattering matrix idea. There is given the detailed consideration of the properties of scattering matrix and its analytic properties in particular. The lectures fill up the gap existing between the university course of quantum mechanics and modern original works on scattering theory and can be the introduction into the theory of nuclear reactions and theory of elementary particles. (auth)

24441 (ITF–69–77) LECTURES ON SCATTERING THEORY. II. Sitenko, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 35p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Lectures on the additional questions of quantum mechanics are continued. The bases of non-relativistic theory of potential scattering are presented. The following questions are considered in the given issue: the particle wave function in external field, optical theorem, time inversion and reciprocity theorem. (auth)

24442 (ITF–69–78) LECTURES ON SCATTERING THEORY. III. Sitenko, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 49p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Lectures on the additional questions of quantum mechanics are continued. The bases of non-relativistic theory of potential scattering are presented. Analytical properties of scattering matrix are considered in the given issue. (auth)

24443 (ITF-69-79) LECTURES ON SCATTERING THEORY. IV. Sitenko, A. G. (Akedemiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 52p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Lectures on the additional questions of quantum mechanics are continued. The bases of non-relativistic theory of potential scattering are considered in the lectures. The following questions are considered in the given issue: dispersional relations, complex moments, and separable representation and scattering amplitude. (auth)

24444 (JINR-E2-4983) ACCOUNT OF RADIATION CORRECTIONS FOR THE EIKONAL SCATTERING AMPLITUDE IN QUANTUM FIELD THEORY MODEL. Barbashov, B. M.; Kuleshov, S. P.; Matveev, V. A.; Sisakyan, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 7p. Dep. CFSTI (U. S. Sales Only).

The eikonal representation for the scattering amplitude taking into account the radiation corrections is obtained by means of the functional integration method. In the approximation used the summation of the radiation corrections leads to the appearance in the expression for the scattering amplitude of the multiplicative factor depending only on the momentum transfer. (auth)

24445 WHAT IS THE POMERANCHUK TRAJECTORY. Cheng, Hung (Massachusetts Inst. of Tech, Cambridge); Wu, Tai Tsun. Phys. Rev. Lett.; 24: 759-61(30 Mar 1970).

The high-energy amplitude in quantum electrodynamics and scalar electrodynamics is calculated, and it is found that the Pomeranchon is a moving Regge pole near $J = \frac{1}{2}$ when t is equal to or near the two-particle threshold, and is a fixed branch point at $J = 1$ for $t \leq 0$. This is due to the promotion from 1 to $\frac{1}{2}$ for the power of s of the tower-diagram amplitudes at threshold. The Gribov paradox is thereby automatically resolved. (auth)

24446 PHENOMENOLOGICAL THEORIES OF HIGH ENERGY SCATTERING. AN EXPERIMENTAL EVALUATION. Barger, Vernon D.; Cline, David B. Frontiers in Physics. New York; W. A. Benjamin, Inc. (1969). 208p.

The discussion of phenomenological theories of high-energy scattering covers particle classification, the general features of scattering data, Regge pole theory, meson exchanges in inelastic reactions, and total cross sections and forward elastic scattering. Also covered are classification, baryon exchange, intermediate-energy scattering, conspiracy and evasion, finite-energy sum rules, and asymptotic projections. (J.F.P.)

24447 ALTERNATIVE TO FINITE-ENERGY SUM RULES. Odorico, R. (Univ., Trieste, Italy. Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Lett. Nuovo Cim.; 1: 571-5(21 Apr 1969).

It is shown how the fixed-transfer dispersion relations can be helpful when finite-energy sum rules cannot be used to use the available phase shifts in order to obtain information on Regge singularities. An application is made to near-forward charge-exchange scattering. (J.F.P.)

24448 EXTRACTION OF THE GEOMETRICAL PART IN A FEYNMAN-GOLDSTONE DIAGRAM. Baz, E. El; Nahabetian, R. S. (Univ., Lyon). Lett. Nuovo Cim.; 1: 583-4(21 Apr 1969).

The geometrical part of a Feynman-Goldstone diagram with any kind of two-body interaction is extracted graphically. A particular case is the Coulomb interaction used previously. It is noted that it is easy to extract the geometrical part of any Feynman-Goldstone diagram after the dynamics of the problem is written, since the rules on the Feynman-Goldstone diagram were not changed. (J.F.P.)

24449 ATTEMPT TO OBTAIN RENORMALIZED RADIATIVE CORRECTIONS BY COMPUTER. Calmet, Jacques; Perrottet, Michel (CNRS, Marseille). Compt. Rend., Ser. B; 269: 1065-9(24 Nov 1969). (In French).

By means of the computer program language LISP, the results obtained during the study of renormalization theory in the framework of a functional formalism were used to construct the Feynman diagrams (quantum electrodynamics, $g\,\phi^3$) and to calculate their finite contributions ($g\phi^3$). (tr-auth)

24450 SKELETONS IN THE REGGE CUPBOARD. Geoffrey, C. Fox (Univ. of California, Berkeley). pp 367-460 of High Energy Collisions. New York; Gordon and Breach, Science Publishers, Inc. (1969).

From 3rd International Conference on High-Energy Reactions, Stony Brook, N. Y. See CONF-690928.

A survey is given of some general properties of Regge poles and cuts. Various reactions that provide particularly potent tests for the theory are then treated, namely, πN charge exchange, pp elastic scattering, πN, KN elastic scattering, photoproduction, backward scattering, and vector meson production. The multi-Regge model is then considered. 96 references. (L.B.S.)

24451 AMPLITUDES INVOLVING EXCITED PARTICLES IN DUAL-RESONANCE MODELS. Carbone, G.; Sciuto, S. (Univ., Turin). Lett. Nuovo Cim.; 3: 246-52(19 Feb 1970).

A procedure is outlined for finding a compact expression for the scattering amplitude for excited particles, which fulfills the requirements of the dual-resonance model. (L.B.S.)

24452 POSITIVITY PROPERTIES OF ABSORPTIVE AMPLITUDES BELOW A PHYSICAL ELASTIC THRESHOLD. Mahoux, G. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Lett. Nuovo Cim.; 3: 221-3(19 Feb 1970).

It is proved that, when there exists a cut in the energy variable below threshold, the absorptive parts of the partial waves satisfy in this region the following inequalities: $(-)^l \text{ Abs } f_l(s) \geq 0$ for $S \leq (m_1 + m_2)^2$. The odd partial waves change sign when s crosses the value $(m_1 + m_2)^2$, whereas the even ones stay positive. (L.B.S.)

24453 EXTENSION OF THE FADDEEV EQUATIONS TO COMPLEX ANGULAR MOMENTUM. Osman, A. (Cairo Univ.). Phys. Lett.; 31B: 506-8(13 Apr 1970).

The integral Faddeev equation for the three-body scattering amplitude is extended to complex values of the angular momentum. The inhomogeneous term of these equations is extended using the Neumann theorem. The Fredholm solution of the Faddeev equations is also considered. (auth)

24454 ELASTIC SCATTERING NEAR 90^0 AT HIGH ENERGIES. Azimov, S. A.; Arushanov, G. G.; Khalmuradov, R. S. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 61-4(1969). (In Russian).

Using the Euler-MacLaurin sum rule, the sum of a number of scattering amplitudes at high energies near 90° is calculated. With certain probable assumptions concerning the behavior of partial amplitudes, the scattering cross section near 90° is described by two parameters, which also describe the scattering cross section near 180°. The results of the calculation are compared with π^+p scattering at a momentum of 3 GeV/c. (tr-auth)

24455 TWISTING-INVARIANT FACTORIZATION OF MULTI-PARTICLE DUAL AMPLITUDE. Amati, D.; Le Bellac, M.; Olive, D. (CERN, Geneva). Nuovo Cim.; 66A: 815-30(21 Apr 1970).

A transformation of variables is exhibited which allows the simultaneous factorization of a multiparticle Veneziano term and its twisted counterpart (obtained by reversing the order of the initial or final particles). The states which factorize the amplitude are linear combinations of those previously obtained which were not invariant under twisting. The behavior of the couplings under twisting allows the definition of a signature factor. The invariance under double twist is automatically satisfied. It is shown that the properties under the aforementioned transformation lead to relations between the couplings of the states to scalar particles (some of them are the ones called "Ward identities" in the literature). (auth)

24456 THE TWISTING OPERATOR IN MULTI-VENEZIANO THEORY. Amati, D.; Le Bellac, M.; Olive, D. (CERN, Geneva). Nuovo Cim.; 66A: 831-44(21 Apr 1970).

Using the operatorial expression for the gauge conditions, an explicit form for the twisting operator and the semi-twisting operator which takes the P states into V states is derived. The expression for the last operator facilitates the proof of the V states factorization previously found by us. It is shown that the twisting operator proposed previously is inconsistent with multiple factorization, i.e. factorization of amplitudes with external spinning particles. The correct twisting operator depends on the integration variables of the twisted line, and automatically satisfies double-twist invariance. (auth)

24457 MASS QUANTIZATION CONDITIONS FROM INFINITE SUPERCONVERGENCE AND CHIRAL SYMMETRY. Englert, F.; Brout, R.; Stern, H. (Univ. Libre, Brussels). Nuovo Cim.; 66A: 845-55(21 Apr 1970).

The single-particle approximation implies the vanishing of all moments of scattering amplitudes which are exotic in the t-channel. These conditions are shown to be consistent with a class of amplitudes which do not identically vanish. A special class of such amplitudes is that of Veneziano. When supplemented by the Adler

condition in the presence of a soft pion, such amplitudes do vanish periodically in t and give rise to mass quantization conditions. Contact is made with the current-algebraic approach used in a previous work. (auth)

24458 DISTORTION OPERATOR METHOD AND PADE APPROXIMANTS. Michalik, B. (Univ., Bonn). Ann. Phys. (N. Y.); 57: 201-13(Mar 1970).

The continuous fraction expression of a partial-wave matrix element following from the distortion operator method developed before is proved to be an S-fraction expansion of the matrix element. The proof is more general, it applies to an arbitrary matrix element of T or K operator. One of our formerly developed approximate schemes is thus proved to be equivalent to the stair-like sequence of Padé approximants; in this way, the Padé method is generated by a sequence of transformations of the original integral equation and, thus, it is not only an algebraic method any more. (auth)

24459 DIAGONALIZATION OF THE INTEGRAL EQUATION FOR MULTIPERIPHERAL DYNAMICS AT VANISHING VALUES OF THE MOMENTUM TRANSFER. Mueller, A. H. (Brookhaven National Lab., Upton, N. Y.); Muzinich, I. J. Ann. Phys. (N. Y.); 57: 20-38(Mar 1970).

The equation written down by Chew and De Tar, for multiperipheral dynamics at zero-momentum transfer, is diagonalized using the expansion theorems for the amplitude in terms of the SO(3, 1) and SO(2, 1) groups, respectively. Extensive use is made of the techniques developed by M. Toller. (auth)

Particle Accelerators

Refer also to abstracts 22718, 23018, 24023, 24305, 24396, and 24520.

24460 (AD-698354) AFCRL FACILITIES OPERATION. Final Report, July 15, 1967-July 15, 1969. Little, Roger; Friedman, Jerome (Ion Physics Corp., Burlington, Mass.). Dec 1969. Contract F19628-67-C-0279. 76p. (AFCRL-69-469). CFSTI.

Two PIN diode detectors were developed for monitoring bremsstrahlung and electron radiation environments. The detectors were calibrated against LiF thermoluminescent dosimeters (TLD). A lithium drifted detector was assembled for gamma ray spectroscopy. The system was calibrated with isotopes of ^{57}Co and ^{133}Ba and found to have a resolution of 20 keV in the 50 to 100 keV range. Bremsstrahlung radiation production from the AFCRL linear accelerator as a function of tungsten target thickness was studied with TLD's maximum on-axis dose at one meter was obtained with a 0.030 inch thick target which agrees with the predicted optimum converter thickness. Using a PIN diode detector system, bremsstrahlung field maps were obtained for several target thicknesses. The linear accelerator 10 MeV electron beam was mapped with both TLD's and a PIN diode detector. Several modifications to the AFCRL LINAC were accomplished. These included a remote trigger, a permanent cable run, an external bremsstrahlung converter, a beam stopper and a rotating wheel sample holder. The latter, when equipped with various foils and a PIN diode detector, can be used to make electron beam range measurements. (auth) (USGRDR)

24461 (CERN-70-6) DESIGN STUDIES FOR A LARGE PROTON SYNCHROTRON AND ITS LABORATORY. Adams, J. B.; Wilson, E. J. N. (European Organization for Nuclear Research, Geneva (Switzerland)). 26 Feb 1970. 57p. Dep. CFSTI (U. S. Sales Only).

A study is presented in which an attempt has been made, using the experience of CERN, Meyrin and that of other similar laboratories, to establish guide lines for the proposed new CERN laboratory and for its principal research tool, a large proton synchrotron. From these generalities some design requirements have been put forward for the accelerator which have led to specific designs for three different types of machines called the fixed-energy machine, the missing-power machine and the missing-magnet machine. The options for future development of the laboratory opened up by the different types of machines are discussed and their costs compared. Finally, other design considerations arising from the need for flexibility for future development are discussed. (W.H.K.)

24462 (CERN-70-9) THE CENTRAL GEOMETRY OF THE SYNCHRO-CYCLOTRON WITH "CALUTRON" SOURCE AND HIGH-FREQUENCY EXTRACTION. Comiti, S.; Giannini, R. (European Organization for Nuclear Research, Geneva (Switzerland)). 17 Mar 1970. 57p. (In French). (Dep. CFSTI (U. S. Sales Only).

Theoretical studies on synchrocyclotrons showed that the performance of such machines can be considerably improved. Therefore a Synchrocyclotron improvement program is under way at CERN, and the different studies dealing with the central region, the RF acceleration, and the extraction system are discussed. The goal of the central region study is to optimize the capture efficiency. This includes the construction of an intense ion source with good initial radial quality; a new central geometry, and the optimization of the acceleration parameters. The small synchrocyclotron of 20 MeV allows an experimental study of the central region, and then a comparison with the theory. By means of a detailed analysis of the first orbits, a central geometry is proposed that maximizes the acceptance and minimizes the radial oscillations. An electrolytic tank is built to compute the orbits with good accuracy. An electric field measurement in three dimensions allows computation of the vertical motion of the proton with space-charge effects included. An internal beam current of about 20 μA is foreseen after machine conversion. (auth)

24463 (IFVE-SKU-69-38) ADJUSTMENT AND VACUUM TESTS OF A SERIES OF ELECTRO-DISCHARGING TITANIUM PUMPS, NEM-1T, FOR THE PROTON I-100 LINEAR ACCELERATOR. Bulgakov, M. K.; Rogozinskii, V. G.; Ushkov, V. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The development and testing of various conditioning procedures for the NEM-1T pumps for the I-100 proton linear accelerator are discussed. (auth)

24464 (JINR-E9-4925) ANALYTICAL CONSIDERATIONS OF THE PROTON BEAM EXTRACTION FROM THE DUBNA SYNCHROPHASOTRON BY EXCITING THE RESONANCE $Q_R = 2/3$. Conte, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1970. 26p. Dep. CFSTI (U. S. Sales Only).

The conditions are considered of the excitation of the radial betatron oscillation resonance $Q_R = 2/3$ for the proton beam extraction from the JINR synchrophasotron. The requirements for the system of the resonance excitation are formulated, the parameters of the necessary perturbations are presented. (auth)

24465 (JPRS-50119) TRANSFORMER-TYPE HIGH-CURRENT ACCELERATOR. Abramyan, E. A.; Gaponov, V. A. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translation of Sil'notochnyy Uskoritel'na Osnove Transformatora. 16p. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 37322.

24466 (LA-4397) PROCEEDINGS OF THE THIRD LAMPF USERS MEETING HELD AT THE UNIVERSITY OF COLORADO, BOULDER, COLORADO, OCTOBER 29, 1969. Agnew, Lewis; Miller, Billie F. (comps.) (Los Alamos Scientific Lab., N. Mex.). 17 Mar 1970. Contract W-7405-eng-36. 53p. Dep. CFSTI.

Reports presented include LAMPF status report, the nucleon-nucleon problem at LAMPF, and potentialities of negative π-meson beams in radiotherapy of cancer. Other topics briefly discussed include pion biomedical problems, stopped muon channel, nucleon physics, pion and particle physics, and the energetic pion channel and spectrometer. (W.H.K.)

24467 (NP-18176) SOURCE OF HIGH-INTENSITY X RAYS IN THE INSTITUTE OF PHYSICS OF UNAM. Limon Marquez, Miguel Angel (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1969. 92p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Thesis.

The interaction of electrons with matter and the continuous x-ray spectrum of the bremsstrahlung radiation are described. In a discussion of the interaction of x rays with matter, the basic theory of the production of x rays by bombarding thick gold targets with high energy electrons and their interaction with matter is summarized. The Van de Graaff accelerator x-ray source, and the characteristics of the x rays from this source are described. The precautions necessary for the protection of the personnel associated with the Van de Graaff accelerator are discussed. Some calculations and experimental routines used with the accelerator are given. (tr-auth)

24468 (PPAD-669-E) ANALOG DATA BREAK INTERFACE. Henness, J. M. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). 30 Oct 1969. Contract AT(30-1)-2137. 19p. Dep. CFSTI.

The interface used for on-line control of the Princeton-Pennsylvania Accelerator with a PDP-9 is described. The specifications for the equipment are considered. The requirements are unique because of the cyclic nature of the synchrotron. Various I/O techniques and the design compromises they require are discussed and the concept of an analog data break interface is outlined. A summary of existing and planned hardware is presented. (auth)

24469 (RI-70-1) MEASUREMENT OF LUMINOSITY DURING AN EXPERIMENT ON THE ORSAY COLLISION RINGS. Petroff, Pierre (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 74p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The luminosity of the Orsay collision ring during the detection of the interaction $e^+e^- \rightarrow K^+K^-$ was measured. This measurement was made with a precision of several percent by recording the counting rate of the double bremsstrahlung reaction $e^+e^- \rightarrow e^+e^-\gamma\gamma$. An automatic recording procedure for the data was developed, and the acquisition data are described. The magnetic bands were analyzed on the Univac 1108 computer. The asymmetry of the spectra of the marked photons was studied, especially with respect to the study of a background in the sandwich computers. The results show that this method of measurement of the luminosity is very precise due to the high counting rate of the normalization reaction used, the absence of background because of the high vacuum in the experimental section, the use of a coincidence system to detect the double bremsstrahlung photons, and the simplicity of the detection apparatus. The very sharp angular distribution of the photons emitted makes it possible to use small-dimension counters having a good energy resolution. (tr-auth)

24470 DESIGN AND CONSTRUCTION OF SACLAY LINEAR ACCELERATOR. Netter, F. (CEN, Saclay, France); Leboutet, H.; Azam, G. Onde Elec.; 49: 1122-35(Dec 1969). (In French).

The Saclay Linear Accelerator is described, and its performance and the principal types are discussed taking into account the technical requirements and economic considerations. Reference is made to the different stages of construction. The accelerator is described on broad lines, as well as its performance after one year's operation. (auth)

24471 SACLAY LINEAR ACCELERATOR AS AN ELECTRON ACCELERATOR. I. CHARACTERISTICS OF THE ELECTRON BEAM. Azam, G.; Bensussan, A.; Leboutet, H.; Tronc, D. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1136-56 (Dec 1969). (In French).

The methods for ensuring spectrum and energy performance are set out in the first part of the chapter devoted to grouping problems. The second part is centered on the problems of the stability of the beam over a period of time. The various parameters which influence this stability are enumerated and analysed. (auth)

24472 SACLAY LINEAR ACCELERATOR AS AN ELECTRON ACCELERATOR. II. MEASURES TO PREVENT THE PHENOMENON OF BEAM BREAK-UP. Aucouturier, J.; Leboutet, H. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1157-66 (Dec 1969). (In French).

After referring to the phenomenon of beam break-up (B.B.U.), the theory of deflecting fields induced by the current is discussed. The conclusions drawn from this lead to the solution adopted in the case of the SLA, where the iris structure of the sections has been modified. Up to the present time, there has been no occurrence of B. B. U. in the SLA. (auth)

24473 SACLAY LINEAR ACCELERATOR AS AN ELECTRON ACCELERATOR. III. RESULTS OBTAINED FROM TESTS ON ELECTRONS. Azam, G.; Bensussan, A.; Leboutet, H.; Perraudin, C. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1167-77(Dec 1969). (In French).

Tests on the head of the machine are described, as well as the results with regard to the energy, spectrum, emission and the phase extension of the elementary group at the exit of the first section. Also, tests carried out on the complete accelerator are described including energy spectrum emission, power of beam, and stability of the machine in long-term operation. (auth)

24474 SACLAY LINEAR ACCELERATOR AS A POSITRON ACCELERATOR. Azam, G.; Bensussan, A.; Leboutet, H.; Perraudin, C. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1178-91(Dec 1969). (In French).

After an analysis of the problem and a description of the solution found, the results relating to the electron-positron converter are described. (auth)

24475 DESCRIPTION OF THE COMPONENTS OF THE SACLAY LINEAR ACCELERATOR. I. ACCELERATORING SECTIONS. Grauleau, D.; Henry-Bezy, G.; Tronc, D. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1192-8(Dec 1969). (In French).

The technology of the accelerating section is described in stages of manufacture, making it possible to follow the section to its completion. The electrical characteristics are given on the basis of a systematically plotted example. (auth)

24476 DESCRIPTION OF THE COMPONENTS OF THE SACLAY LINEAR ACCELERATOR. II. MODULATORS. Bonvalot, B.; Defossez, G.; Pouree, J. L. (Thomson-CFS, Corbeville, France). Onde Elec.; 49: 1199-1207(Dec 1969). (In French).

After a review of the general characteristics of power modulators, it is explained why nonsaturated hard tubes techniques are chosen. Then all the stages, the feedback aimed to increase the stability of amplitude, the coupling pulse transformers, and the security systems are described. (auth)

24477 DESCRIPTION OF THE COMPONENTS OF THE SACLAY LINEAR ACCELERATOR. III. KLYSTRONS. Delaye, A.; Romiguiere, R. Onde Elec.; 49: 1208-9(Dec 1969). (In French).

The performance of the klystron hf accelerator sources for the Saclay Linear Accelerator is described. (auth)

24478 DESCRIPTION OF THE COMPONENTS OF THE SACLAY LINEAR ACCELERATOR. IV. HF CHAINS AND THE PILOT. Azam, G.; Roux, G. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1210-15(Dec 1969). (In French).

The hf chains include the low level chain which connects the pilot to the power klystrons, and the high level chain which supplies the hf power to the accelerator sections. The description and performance of the pilot and the two chains are presented. (auth)

24479 DESCRIPTION OF THE COMPONENTS OF THE SACLAY LINEAR ACCELERATOR. V. BEAM ALIGNMENT. Fontan, J.; Roux, G. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1216-20(Dec 1969). (In French).

A solution to the problem of accelerator beam alignment, by a method involving the use of a laser beam, is described. (auth)

24480 DESCRIPTION OF THE COMPONENTS OF THE SACLAY LINEAR ACCELERATOR. VI. PUMP ASSEMBLY. Azam, G.; Bensussan, A.; Perraudin, C. (Thomson-CSF, Corbeville, France). Onde Elec.; 49: 1220-4(Dec 1969). (In French).

After enumerating the criteria governing the choice of the solution applied, the vacuum pump unit and its performance are described. (auth)

24481 BEAM DETECTORS AND ASSOCIATED ELECTRONICS. Bechade, J.; Le Baud, P. (CEN, Saclay, France). Onde Elec.; 49: 1225-34(Dec 1969). (In French).

Instruments to measure the intensity of the beam current and beam position detectors are described. The performance achieved, as a function of the current and the repetition frequency, is indicated. (auth)

24482 RADIATION DETECTION AND SECURITY MEASURES AGAINST ACCESS AT SACLAY LINEAR ACCELERATOR. Male, J.; Vialettes, H. (CEN, Saclay, France). Onde Elec.; 49: 1235-41(Dec 1969). (In French).

Radioprotection around the Saclay Linear Accelerator is discussed, and problems for transferring and using beams having a power equal or higher than 100 kW are described. Radiation sources, detectors and their measuring lines, and alarms for access locking to experimental rooms, with some measuring results in different places are described. (auth)

24483 NEW METHOD OF CALCULATING THE ENERGY AND PHASE OF ELECTRONS INJECTED IN SMALL BUNCHES IN PHASE IN A LINEAR ACCELERATOR. Boussoukaya, Mustapha; Septier, Albert (CNRS, Orsay, France). Compt. Rend., Ser. B; 269: 1205-8(15 Dec 1969). (In French).

A method is given for calculating analytically the energy and phase of electrons in a low-current accelerator, permitting the determination of the energy spectra of accelerated electrons. Also the grouping in phase at exit from the machine is determined when the injected beam is cut into bunches with a phase less than 20°. (tr-auth)

24484 ATTENUATION COEFFICIENT OF A PROGRESSIVE WAVE PROPAGATING IN A SUPERCONDUCTING WAVEGUIDE. Zepp, Gerard (Laboratoire de Physique Theorique, Puy-de-Dome, France). Compt. Rend., Ser. B; 269: 1082-4(24 Nov 1969). (In French).

The effect is studied of the variation of the mean free path (in the presence of impurities) on the attenuation coefficient of an electromagnetic wave propagating in a wave guide made of a superconducting material of high coherence length. (J.F.P.)

24485 LINEAR ELECTRON ACCELERATORS FOR STERILIZATION AND RADIATION CHEMISTRY. Levin, V. M.; Nikolaev, V. M.; Semenov, A. N.; Shahov, V. I.; Kokorin, A. M.; Moontyan, V. I.; Rumyantsev, V. V.; Fomin, L. P.; Shchepin, J. P. (Scientific Research Inst. of Electrophysical Apparatus, Leningrad). Technical Meeting No. 8/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The energy of the accelerated electrons at the accelerator exit is 5 to 15 MeV. The electron flux intensity is 5 to 10 KW The accelerators have devices for scanning the electron flux into a band up to 500 mm. The accelerators can be manufactured in two versions including vertical and horizontal accelerating systems. (auth)

24486 CRITERION FOR COMPARING ANALYZERS. Sar-El, H. Z. (Soreq Nuclear Research Centre, Yavne, Israel). Rev. Sci. Instrum.; 41: 561-4(Apr 1970).

In view of the recent development of several new electrostatic analyzers, the need arises for a criterion for comparing their figures of merit. A criterion usually used in β spectrometry is proposed and is shown to be preferable to another criterion proposed recently. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstract 24167.

24487 (GEMP-728) SPECTRA PROGRAM USER'S MANUAL. Baumgardt, N. R. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). Dec 1969. Contract AT(40-1)-2847. 197p. Dep. CFSTI.

The SPECTRA Program uses Monte Carlo techniques to describe neutron collision sequences in a material under irradiation. The number of primary knock-on atoms resulting from these collisions and their energy spectra are computed. This report is a user's manual for the revised version of SPECTRA and the two related programs, 20-4 and the SPECTRA Input Program. All of these programs were written for the IBM 7090-94 computers. SPECTRA is written in FAP and the SPECTRA Input Program and 20-4 are written in FORTRAN II. (auth)

24488 (STI/DOC-10/100) AN INTERNATIONAL NEUTRON DATA SYSTEM. Findings of a Panel on Neutron Data Compilation Organized by the International Atomic Energy Agency and Held in Brookhaven, 10-14 February 1969. Technical Reports Series No. 100. (International Atomic Energy Agency, Vienna (Austria)). 1969. 42p. Dep. IAEA $2.00. $0.65 mn.

The results of panel deliberations based on papers contributed concerning neutron data compilation are presented. An appraisal is given of the current and future needs for nuclear data compilation, of the role of the world's principal neutron data centers, and of the development of the world's principal neutron data centers. The conclusions and recommendations of the panel are presented. (J.W.R)

24489 EIGENFUNCTIONS EXPANSION METHOD FOR NEUTRON WAVE PROPAGATION PROBLEM. Yamagishi, Tomejiro (Osaka Univ.). Technol. Rep. Osaka Univ.; 19: 301-9(Oct 1969).

The eigenfunctions of the Boltzmann equation with the synthetic kernel for neutron wave propagation problems, which were previously developed by Kaper, are shown to have the orthogonality properties in the half-range case. These orthogonality relations greatly facilitate obtaining the coefficients of the eigenfunction expansion in plane geometry and are applied to the albedo problem. (auth)

24490 A NEW NUMERICAL STUDY OF THE FAST NEUTRON SPECTRUM IN A HOMOGENEOUS MEDIUM. Yamamura, Yasunori; Sekiya, Tamotsu (Osaka Univ.). Technol. Rep. Osaka Univ.; 19: 311-19(Oct 1969).

A new numerical method for the study of the slowing down of fast neutrons produced uniformly in an infinite homogeneous medium is described. Its numerical application to light water is performed emphasizing the following: the effect of the anisotropy in the c. m. s.; the comparison of the method with G. G. approximation; and the effect of inelastic scattering. (auth)

24491 A STUDY OF THE PULSED NEUTRON PROBLEM IN ICE IN THE TEMPERATURE RANGE 273 TO 21°K. Tewari, S. P.; Kothari, L. S. (Univ. of Delhi). Nucl. Sci. Eng.; 39: 193-206(Feb 1970).

Calculations on the decay of a neutron pulse in H_2O ice assemblies of various bucklings and at various temperatures in the range 273 to 21°K are reported. The scattering kernel is based on the Debye frequency distribution function of lattice vibrations, with a suitably chosen Debye temperature. Contributions from one- and two-phonon processes were considered. The Boltzmann equation in the diffusion approximation was solved both by an iterative procedure to obtain the fundamental mode of decay, and by a matrix diagonalization method. This latter method enables one to calculate neutron spectra at various times after the introduction of the neutron pulse. These time-dependent spectra were compared with available experimental results with considerable success. By studying the time variation of the mean energy of the neutron distribution, the slowing down relaxation times τ_{th} in ice at various temperatures were determined and these were compared with the measured values. The heating up of a low-energy neutron pulse in ice assemblies at a few temperatures was also studied and it was found that, unlike the case of beryllium (Grover and Kothari) the heating up relaxation time τ_H comes out to be nearly the same as τ_{th}. The calculated values of diffusion coefficient D_θ, and diffusion cooling coefficient C at various temperatures were compared with the experimental results. The agreement between the two sets of values is very good for D_θ, but not so good for C. (auth)

24492 SCATTERING OF SLOW POLARIZED NEUTRONS IN ANTIFERROMAGNET PLACED IN A STRONG MAGNETIC FIELD. Zarochentsev, E. V. Ukr. Fiz. Zh.; 14: 1867-73(Nov. 1969). (In Russian).

The scattering cross sections of slow polarized neutrons were calculated in two-sublattice antiferromagnets placed in a strong magnetic field. The formulas are obtained for scattering line widths and their shifts depending on the temperature, for the external magnetic field value and that of the impulse transferred to neutron at scattering, as well as for the polarization vector of scattered neutrons. (auth)

24493 OPERATOR FORMULATION OF RESONANCE ABSORPTION OF NEUTRONS. Corcuera, R. Paviotti; Solanilla, R. (Comision Nacional de Energia Atomica, Buenos Aires). J. Nucl. Energy; 23: 643-54(Dec 1969).

Operational calculus may be used to obtain exact expressions for the resonance integral and the intermediate resonance parameters. These expressions are obtained for the more general case of a heterogeneous system of one resonance absorber with N admixed moderators and M moderators. The trial functions for the fluxes needed in the calculus are obtained by means of a linear approximation for the slowing down operators. The intermediate resonance parameters are introduced with physical meaning. Three approximations are used for calculating the resonance integral, and they are applied to several resonances in homogeneous and heterogeneous systems. The three approximations are then compared with Monte Carlo calculations. One of them is found to be in very good agreement with Monte Carlo results. Finally, the general formulation given here includes many of the I-R methods developed up to the present. (auth) (UK)

24494 RAPID INVERTING OF THE POLARIZATION OF A NEUTRON BEAM USING LARGE AMPLITUDE OSCILLATING MAGNETIC FIELDS. Kendrick, H. (Univ. of Michigan, Ann Arbor); King, J. S.; Werner, S. A.; Arrott, A. Nucl. Instrum. Methods; 79: 82-92(1970).

During the course of designing and constructing a pulsed-neutron-polarization-inverter (PNPI) to be used in the study of magnetic excitations in solids, it was necessary to reexamine the oscillating field method of magnetic resonance in the region where the amplitude of the rf field B_1 is comparable to the dc field B_0. It is found that the phase of the rf field at the instant the neutron enters the spatial region of the field becomes an increasingly important consideration as B_1/B_0 becomes comparable to 1. Analog and digital computer solutions are given for the equations of motion of the neutron's magnetic moment in the presence of various field configurations important in the construction of a PNPI. (auth)

24495 ATOMIC MOTION IN LIQUID SODIUM. I. DIFFUSIVE MOTION. Cocking, S. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. C (London); 2: 2047-62 (Nov 1969).

The time-of-flight technique was used to measure the energy spectra of initially cold neutrons after scattering by liquid sodium at 115, 149, and 197°C. Nearly elastic peaks were observed, and were compared with predictions from the model of Egelstaff and Schofield (1962) for atomic translational motion. Peak shapes and intensities were accurately fitted, and a disposable parameter c which describes the approach to the long-time behavior given by Einstein's stochastic description was determined at each temperature. The peak widths are in disagreement with the model of Singwi and Sjolander (1960), but in accord with an extension of this model by Oskotskii (1963). An essential feature of Oskotskii's extension is the concept of the collective diffusion of groups of atoms, and this type of motion is found to account for 40% of the total diffusion coefficient of sodium. The parameter c of the Egelstaff-Schofield model may be interpreted as giving the mean number of atoms in a diffusing group; the data yield a number of 30 ± 1 atoms, which was essentially constant over the temperature range studied. A comparison of these results with less extensive data for liquid lead and tin is made, and it is suggested that diffusive motion of groups of several tens of atoms could be a common feature of liquid metals. By contrast, a comparable analysis of data for liquid argon gives a number of atoms less than four for the size of any such group. (auth) (UK)

24496 STOCHASTIC MODEL FOR NEUTRON SCATTERING BY SIMPLE LIQUIDS. Desai, R. C.; Yip, S. (Massachusetts Inst. of Tech., Cambridge). Advan. Chem. Phys.; 15: 129-36 (1969).

From Conference on Stochastic Processes in Chemical Physics, San Diego, Calif. See CONF-680331.

A simple interpolation model for single particle motions in simple liquids was derived previously (Phys. Rev., 166: 129(1968)). This derivation, based on the correlation function formalism, depended on dispersion-relation and sum-rule arguments and the assumption of simple exponential decay for the damping function and treated oscillatory and diffusive motions of an atom in terms of a single equation. An analysis of the energy distribution of neutrons scattered by hydrogen in liquid argon at 100°K and 26.5 atm, as a function of time of flight for various scattering angles, is given using the interpolation model, Sears' itinerant oscillator model (Sears, V. F.; Proc. Phys. Soc., 86: 965(1965)), and experimental figures. The results are discussed. (UK)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 24215, 24246, 24247, and 24397.

24497 (ORNL-TM-2880) UKE: A COMPUTER PROGRAM FOR TRANSLATING NEUTRON CROSS SECTION DATA FROM THE UKAEA NUCLEAR DATA LIBRARY TO THE EVALUATED NUCLEAR DATA FILE FORMAT. Wright, R. Q.; Cramer, S. N.; Irving, D. C. (Oak Ridge National Lab., Tenn.). Mar 1970. 19p. Dep. CFSTI.

A computer program, UKE, was written to translate neutron cross sections on computer tape from the United Kingdom Atomic Energy Authority Nuclear Data Library to the Evaluated Nuclear Data File, ENDF/B. The code will translate UK library smooth cross section data, secondary angular distributions, and secondary energy distributions to the ENDF/B format. No resonance parameters, thermal scattering data, or photon data are considered, however. The secondary angular distributions are translated as differential scattering probabilities only, and no Legendre expansion coefficients are given. General information is presented concerning the format of the two libraries along with a detailed description of the translation from the UK secondary energy distribution laws to those of ENDF/B. Programming details and a user's guide are also presented. (auth)

24498 SHELL-MODEL ANALYSIS OF THE EXCITED STATES OF ^{4}He. Szydlik, P. P. (State University Coll., Plattsburgh, N. Y.). Phys. Rev., C; 1: 146-55(Jan 1970).

Using a theory previously developed for the ^{16}O nucleus, the energy levels of ^{4}He were calculated using the nuclear shell model and the random-phase approximation (RPA). Though no attempt was made to optimize the parameters of the calculation, the predicted energies of the excited states compare favorably with those determined from experimental analyses. Qualitative agreement with experiment is obtained for the calculated electron inelastic-scattering form factor to the first 0^+ excited state and for the integrated photoabsorption cross section. However, the prediction of the majority of the E1 strength in the higher of the 1−, T = 1 levels does not conform to most experiments which indicate the lower level to have the stronger $^1P_1$ component. The RPA produces some improvement over an ordinary shell-model calculation by decreasing the energies of the lower excited states by several hundred keV and by increasing the relative E1 strength of the lower 1−, T = 1 level. (auth)

24499 PHOTODISINTEGRATION OF THREE-PARTICLE NUCLEI. Barbour, I. M.; Phillips, A. C. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., C; 1: 165-79(Jan 1970).

It is shown that the ^{3}He and ^{3}H photodisintegration reactions are to a large extent independent of the detailed properties of the three-nucleon ground state, but depend crucially on the nuclear interaction in the final continuum states. The bound-state properties considered are the analytic form of the principal S state, the asymptotic behavior, the S′ state, and the two-nucleon short-range repulsion. Since the rms radius of the bound state determines the over-all magnitude of the cross section, predictions of different wave functions with the same radius are compared. The final states are described by the Faddeev equations in the separable approximation. If the final-state interactions are correctly included, then the low-energy cross sections for the ^{3}He(γ,p)d reaction are enhanced by 20–25%, and the cross sections for ^{3}He(γ,n)2p are reduced by approximately 100%. A simultaneous but rough agreement is possible for the total two and three-body breakup cross sections and the charge form factors of the three-particle nuclei; but, within the theoretical framework adopted, the two-body differential cross sections at 90° and the charge-form-factor data cannot be reconciled. (auth)

24500 STUDY OF THE EXCITED STATES IN ^{4}He THROUGH THE ^{4}He(γ,p)^{3}H REACTION. Sanada, Junpei; Yamanouchi, Mikio; Sakai, Nobuhiko; Seki, Seiji (Tokyo Univ. of Education). J. Phys. Soc. Jap.; 28: 537-41(Mar 1970).

Proton spectra from the ^{4}He(γ,p)^{3}H reaction with 32-MeV bremsstrahlung X-rays were measured at 45, 90 and 135° lab angles. Two broad peaks were found at 24 and 27 MeV, and a local minimum at 26 MeV in the excitation function. The $\sin^2\theta$ angular distribution at the two peaks suggests that the reaction proceeds mainly through E1 absorption. An analysis of the data in terms of two non-interfering resonances shows that the lower 1^- T = 1 state at 25 MeV in ^{4}He is mainly a $^1P_1$ configuration. (auth)

24501 THRESHOLD ELECTRODISINTEGRATION OF THE DEUTERON. Ricco, G.; Drake, T. E.; Katz, L.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon, Can.). Phys. Rev., C; 1: 391-7(Feb 1970).

The electrodisintegration of the deuteron near threshold was investigated by inelastic electron scattering at momentum transfers q = 0.35 F^{-1} and q = 0.66 F^{-1} and scattering angles θ = 125, 140, and 155°. The longitudinal and transverse matrix elements to the final $^1S_0$ and $^3S_1$ states were compared with the Jankus–Durand theory using repulsive-core wave functions. The repulsive-core parameter, corresponding to a radius of about 0.2 F, was adjusted to fit the elastic deuteron form factors up to q = 6 F^{-1}. The computed inelastic cross sections give a satisfactory description of the existing data in the whole momentum-transfer range experimentally investigated: (0.35 $F^{-1} \le q \le 3$ F^{-1}). (auth)

24502 NUCLEON–NUCLEUS FORWARD DISPERSION RELATIONS. Ericson, T. E. O.; Locher, M. P. (CERN, Geneva). pp 389-94 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Elastic forward dispersion relations are illustrated by n-α scattering and preliminary results are given. Exchange effects are of great importance at low energies. This conclusion should be generally valid for light nuclei. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 24215, 24230, 24297, 24497, 24551, 24620, 24634, and 24635.

24503 (JINR-P1-4876) ELASTIC SCATTERING OF FAST PROTONS BY LIGHT NUCLEI. Komarov, V. I.; Kosarev, G. E.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The experiment is described, which was performed with the aim of detecting elastic backward scattering of 665-MeV protons by ^{6}Li. The ^{6}Li recoil nuclei knocked out from the target at an angle of 5.4° to the proton beam direction were identified by the effective momentum, the time-of-flight on two bases, ionization energy losses in three scintillation counters, and the range. For the discrimination of a random time coincidence of the secondary beam particles their tracks were recorded by the isotropic discharge chamber with an image intensifier. The upper limit of the differential cross section of elastic p-^{6}Li scattering at 196° cms was established to be 2.5×10^{-34} $cm^2 \cdot sr^{-1}$. The known experimental data including the cross section $(9.9 \pm 2.3) \times 10^{-31}$ $cm^2 \cdot sr^{-1}$ for p-^{3}He and $(1.1 \pm 0.3) \cdot 10^{-31}$ $cm^2 \cdot sr^{-1}$ for p-^{4}He scattering at 169° cms are compared with the theoretical estimates. They are based on the assumption that elastic scattering with the high value momentum transfer to the nucleus is realized by the direct interaction of the incident proton with the nucleus being in a fluctuation compression state in volume with the dimension $R \approx \hbar/q$. Such a comparison shows that the fluctuation model proposed by D. I. Blokhintsev describes correctly the absolute value and the energy dependence (T_p = 100–1000 MeV) of the differential cross section of the backward elastic scattering for all stable light nuclei from deuterons to ^{6}Li. (auth)

24504 ^{6}Li(γ,t)^{3}He AND ^{6}Li(γ,pd)^{3}H REACTIONS. Murakami, Akira (Sage Univ., Japan). J. Phys. Soc. Jap.; 28: 1-10(Jan 1970).

Nuclear emulsions loaded with ^{6}Li were irradiated with 32-MeV bremsstrahlung x rays. A clear discrimination of the reactions was made by the use of a momentum balance method. The ^{6}Li(γ,t)^{3}He cross section shows a peak at $E_\gamma \simeq 21$ MeV with the maximum value 5.1 mb. The angular distribution of phototritons corresponding to the peak energy shows an asymmetry around 90° indicating an interference between E1 and E2 absorptions. The

^{6}Li(γ,pd)^{3}H cross section has the maximum value 5.8 mb at E_γ = 24 ~ 25 MeV. The cross sections of these reactions integrated up to 32 MeV are 12.8 ± 1.9 mb·MeV and 18.2 ± 2.0 mb·MeV, respectively. They make the total integrated photon absorption cross section to have a reasonable value expected from the E1 sum rule. Present data are compared with the predictions of the models for ^{6}Li proposed so far. (auth)

24505 T = 3/2 LEVELS IN ^{11}B FROM THE ^{10}Be(p,γ_0)^{11}B REACTION. Goosman, D. R. (California Inst. of Tech., Pasadena) Adelberger, E. G.; Snover, K. A. Phys. Rev., C; 1: 123-8(Jan 1970).

The differential cross section for the ^{10}Be(p,γ_0)^{11}B reaction was measured at 90° for 0.6 ≤ E_p ≤ 6.3 MeV. Compound resonances in ^{11}B were located at (12.17 ± 0.04)-, 12.55 ± 0.03-, 12.91 ± 0.02-, 14.33 ± 0.02-, and 15.3 ± 0.1-MeV excitation energy. The last four are probably analogs to the lowest four levels in ^{11}Be. Total widths and ground-state γ-ray widths of these levels are presented. The spins of the 12.55- and 14.33-MeV levels are shown to be $\frac{1}{2}^+$ ($\frac{3}{2}^+$) and $\frac{5}{2}^{(+)}$ ($\frac{3}{2}^-$), respectively. (auth)

24506 FADDEEV TREATMENT OF ^{6}Li WITH A SEPARABLE POTENTIAL. Shah, M. S. (Physical Research Lab., Ahmedabad, India); Mitra, A. N. Phys. Rev., C; 1: 35-9(Jan 1970).

The nucleus ^{6}Li, together with its first excited state ^{6}Li*, is treated as a three-body problem consisting of an α particle, a proton, and a neutron, interacting through separable potentials in pairs. The N-N potential includes a tensor force in addition to a central (S-wave) term of the Yamaguchi type. The p-wave part of the α-N potential is parametrized in terms of the sum of a central and a small spin-orbit term which fits the experimental $P_{\frac{1}{2}}$ and $P_{\frac{3}{2}}$ α-N phase shifts quite accurately. The smallness of the spin-orbit part justifies its omission from the full three-body equations. The binding energies and the wave functions for the ground ($J^\pi = 1^+$) and excited ($J^\pi = 0^+$) states of ^{6}Li are calculated by solving the coupled Faddeev equations numerically. The calculated binding energy for the 1^+ state is a little higher than, and that for the 0^+ state a little lower than, the corresponding experimental values, corrected for Coulomb effects. (auth)

24507 ELECTRON SCATTERING AND MUON CAPTURE BY ^{12}C AND ^{16}O IN A CONTINUUM MODEL. Friar, J. L. (Stanford Univ., Calif. Univ. of Washington, Seattle). Contracts F44620-68-C-0075; AT(45-1)-1388. Phys. Rev., C; 1: 40-55(Jan 1970).

The giant resonance region of ^{12}C and ^{16}O is investigated using a continuum model, which is based on configuration mixing of negative-parity particle-hole states, with the particle in the continuum. Using this model T = 1, $J^\pi = 1^-$, and 2^- electron-scattering spectra are calculated as well as the 0^-, 1^-, and 2^- nuclear-excitation spectra (or equivalently the neutrino spectra) in μ capture. The SU(4) relationship $M_P^2 = M_V^2 = M_A^2$ is tested and found to be satisfied in both nuclei to better than 10%. In addition, the relationship $(M_V^2) = (M_V^2)_{UD} |F_{el}(\nu^2_{res})|^2$ is tested and found to hold to within 3%. Both of these results justify the previous work of Foldy and Walecka on calculations of total-muon-capture rates. The detailed behavior of the electron scattering spectra is examined as a function of momentum transfer with emphasis on the magnetic contribution to the 1^- transverse electric spectra and the giant magnetic quadrupole resonances. The momentum dependence of integrated form factors for certain regions of the excitation spectra is also investigated. (auth)

24508 DISTORTED-WAVE ANALYSIS OF QUASIFREE PROTON INELASTIC SCATTERING. Kroll, F. R.; Wall, N. S. (Univ. of Maryland, College Park). Contract AT(40-1)-3491. Phys. Rev., C; 1: 138-45(Jan 1970).

Using a complex square-well distorting potential, the quasifree inelastic scattering of protons was calculated in the impulse approximation. Calculations were performed for the nucleus ^{12}C at both 160 and 1014 MeV to compare with experiment. The calculation was done with parameters determined from other data and was therefore essentially parameter-free. The agreement with experiment is quite satisfactory and relatively independent of the parameters. While the magnitude of the cross section is well determined, the location of the quasifree peak is in disagreement with experiment and only slightly shifted from the no-distortion case. (auth)

24509 SCATTERING OF 19 TO 30-MeV ALPHA PARTICLES FROM ^{12}C. Morgan, James F.; Hobbie, Russell K. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 1: 155-64(Jan 1970). (COO-1265-78).

Elastic and inelastic excitation functions and differential cross sections of α particles scattered from ^{12}C were measured. Excitation functions were taken from 18.90 to 30.06 MeV in 20-keV steps. Differential cross sections were measured at the energies of anomalies in the excitation functions. Optical-model and phase-shift fits to the elastic angular distributions were attempted without success. A statistical analysis of the excitation function indicates that the reaction is proceeding mainly through the compound nucleus with a coherence width Γ of 360 keV (c.m.). (auth)

24510 MEASUREMENTS OF THE VECTOR POLARIZATION OF DEUTERONS FROM (p,d) REACTIONS AT 185 MeV USING A CARBON POLARIMETER. Ingemarsson, A.; Sundqvist, B. (Univ. of Uppsala). Ark. Fys.; 39: 429-37(Oct 1969).

The vector polarization of deuterons produced in the reactions beryllium-9(p,d)beryllium-8, carbon-12(p,d)carbon-11, and silicon-28(p,d)silicon-27 was measured. The analyzing power of the carbon polarimeter used was estimated with the aid of published data on elastic scattering of deuterons at the energies of 125 and 156 MeV. The observed vector polarizations were very small. (auth) (SW)

24511 PRODUCTION OF THE LIGHT ELEMENTS LITHIUM, BERYLLIUM, AND BORON BY PROTON SPALLATION OF ^{12}C. Davids, Cary N.; Laumer, Helmut; Austin, Sam M. (Michigan State Univ., East Lansing). Phys. Rev., C; 1: 270-5(Jan 1970).

Cross sections for the production of the light elements lithium, beryllium, and boron by proton bombardment of ^{12}C were measured for proton energies between 21.7 and 44.0 MeV. Time-of-flight methods were used to identify the masses of ions recoiling from a thin target into a semiconductor detector. The results are related to current models on the origin of these light elements, and are consistent with a suggestion that the ^{11}B/^{10}B isotopic ratio has remained unaltered at its formation value. (auth)

24512 ^{18}F STATES WITH LARGE ISOSPIN IMPURITIES. Tollefsrud, P. B.; Jolivette, P. L. (Univ. of Wisconsin, Madison). Phys. Rev., C; 1: 398-407(Feb 1970).

Extensive differential cross-section measurements for ^{14}N(α, α_1)^{14}N over the energy range 10.2 ≤ E_α ≤ 18.24 MeV are reported. The α_0 and α_2 exit channels are isospin-allowed, while α_1 is isospin-forbidden. Except for the Coulomb elastic scattering contribution to α_0, compound-nucleus formation dominates all three channels. The α_1 channel displays relatively isolated resonances which imply ^{18}F states with large isospin impurities. These α_1 data, when expanded in partial waves, fix J^π for many of the ^{18}F levels (~20). Comparison of ^{14}N(α,α_1)^{14}N with ^{16}O(d,α_1)^{14}N data (some old and some new data) suggests that the same ^{18}F states are usually involved. The estimated isospin impurities are ~10-25% and are still present at $E_x(^{18}F)$ ~ 18 MeV. The data suggest that the isospin-impure levels in ^{18}F tend to occur as doublets, and that for low partial waves isospin may be rather well conserved at our higher excitation energies. The data do not support Noble's suggestions concerning the importance of direct reactions in isospin-violating reactions. (auth)

24513 OCTUPOLE AND QUADRUPOLE TRANSITION RATES IN ^{19}F FROM SCATTERING OF 15-MeV DEUTERONS. Dehnhard, D.; Hintz, Norton M. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 1: 460-7(Feb 1970).

Angular distributions of 15.0-MeV deuterons scattered by ^{19}F were measured between θ_{lab} = 18 and 85°. Inelastic groups leaving ^{19}F in its five lowest-lying excited states were observed using two position-sensitive detectors placed in the focal plane of a split-pole spectrometer. The elastic-scattering cross section was analyzed using an optical model. B(E2) ↓ values for the transitions from the $\frac{5}{2}^+$ (0.197-MeV) and the $\frac{3}{2}^+$ (1.56-MeV) states to the ground state were found to be 9 ± 3 and 10 ± 3 W.u. (single-particle units). They were calculated from the β_2 deformation parameter extracted from a distorted-wave Born-approximation (DWBA) analysis using a complex form factor derived from the optical-model analysis with a surface-absorption term. These results are in good agreement with results obtained from inelastic proton scattering and from Coulomb-excitation experiments. However, the B(E3) ↓ value for the $\frac{5}{2}^- \rightarrow \frac{1}{2}^+$ transition from the 1.35-MeV state was found to be 1.4 ± 0.6 W.u. as compared to the upper limit of 3.8 ± 0.6 W.u. from a (p,p') experiment, and to 12.0 ± 4.0 and 7.6 ± 1.3 W.u. from two different Coulomb-excitation experiments. The results are compared to various model predictions. (auth)

24514 CALCULATIONS ON NUCLEAR-TRANSFER REACTIONS BETWEEN HEAVY IONS. Schmittroth, F. (Case Western Reserve Univ., Cleveland); Tobocman, W.; Golestaneh, A. A. Phys. Rev., C; 1: 377-84(Feb 1970).

Finite-range stripping calculations are made for heavy-ion reactions which involve nucleon transfer. Three reactions were studied, ^{16}B(^{14}N,^{13}N)^{11}B, ^{27}Al(^{16}O,^{15}N)^{28}Si, and ^{11}B(^{16}O,^{15}N)^{12}C, which span energy regions below, near, and above the Coulomb barrier, respectively. At the low energies, there is quantitative agreement with experimental angular distributions and total cross sections. At higher energies, the agreement with experiment deteriorates as the results become more sensitive to the optical-model parameters used in the calculations. The effects of a repulsive core are noted, and attempts are made to fit some ^{16}O-^{11}B elastic scattering data. (auth)

24515 EXCITATION OF COLLECTIVE STATES IN LIGHT NUCLEI BY INELASTIC SCATTERING OF 20.3-MeV POLARIZED PROTONS. Blair, A. G. (Los Alamos Scientific Lab., N. Mex.); Glashausser, C.; de Swiniarski, R.; Goudergues, J.; Lombard, R.; Mayer, B.; Thirion, J.; Vaganov, P. Phys. Rev., C; 1: 444-59(Feb 1970).

Asymmetries and relative differential cross sections were measured for elastic and inelastic scattering of 20.3-MeV polarized protons from light elements. The targets included ^{12}C, ^{16}O, ^{24}Mg, ^{25}Mg, ^{26}Mg, ^{27}Al, ^{28}Si, and ^{40}Ca. Significant differences were observed in both the asymmetries and cross sections for transitions with a given angular momentum transfer. The shapes of the asymmetries for ^{27}Al and ^{28}Si show some disagreement with the weak-coupling model prediction. Coupled-channels and distorted-wave Born-approximation calculations (DWBA) were performed for the first 2^+ and 4^+ states in ^{24}Mg and ^{28}Si, with several types of deformed spin-orbit potential. In principle, it should be possible with a coupled-channel analysis to distinguish between vibrational and rotational models, and between positive and negative deformations. In fact, there are differences between the predictions of these models. However, none of them gives a good account of the 2^+ and 4^+ asymmetries in ^{24}Mg and ^{28}Si, even when the full Thomas form of the spin-orbit potential is used. Microscopic- and macroscopic-model DWBA predictions of the 3_1^- and 5_1^- asymmetries in ^{40}Ca yield fair agreement with the experimental data. (auth)

24516 CROSS SECTIONS OF Li, Be, AND B EMITTED IN 125-MeV p AND 90-MeV α-PARTICLE INTERACTIONS WITH C AND N: APPLICATION TO NUCLEOSYNTHESIS. Jung, M.; Jacquot, C.; Baixeras-Aiguabella, C.; Schmitt, R ; Braun, H. (Centre de Recherches Nucleaires, Strasbourg). Phys. Rev., C; 1: 435-44(Feb 1970).

The production cross sections for Li, Be, and B fragments emitted in medium-energy proton and α-particle reactions with the C, N, and O nuclei of a nuclear emulsion were measured. The corresponding results for the p-induced and α-induced reactions have been compared. Since helium abundance in the universe is about 10%, these reactions must be taken into account when considering the nucleosynthesis of Li, Be, and B. (auth)

24517 EXPERIMENTAL INVESTIGATION OF THE ELASTIC SCATTERING OF PROTONS ON ^{10}B. Boreli, F. (Boris Kidric Inst. of Nuclear Science, Belgrade); Little, R.; Rego, A. Fizika (Zagreb); 2: 19-26(1 Jan 1970).

Excitation functions for the elastic scattering of protons on ^{10}B were measured at a CM angle near 90, 125 and 150°, in steps of 20 keV, for proton energies between 3 and 10.5 MeV. Angular distributions of elastically scattered protons were measured in steps of 100 keV in the same energy range. Angular distributions change appreciably with the incident proton energy up to 7.5 MeV. Above this energy small changes and forward peaking of the angular distributions indicate that the direct reaction mechanism prevails. Resonances in the elastic cross section were found at 3.6, 4.4, 5.3, 5.7, 5.9, 6.4, 6.7, 7.6, and 8.9 MeV incident proton energy. They correspond in all cases to the positions of resonances which appear almost always only in a few reaction channels. For the state at 12.7 MeV (E_p = 4.4 MeV), 13.4 MeV (E_p = 5.3 MeV) and 16.8 MeV (E_p = 8.9 MeV) tentative assignments of $^1/_2^+$, $^3/_2^+$ or $^{11}/_2^+$ for the spin and parity are made, and for the last one that it is formed with l = 0 or l = 2, are given. (auth)

24518 MUON-CAPTURE RATE IN ^6Li AND THE PCAC HYPOTHESIS. Kim, C. W.; Mintz, S. L. (Johns Hopkins Univ., Baltimore). Phys. Lett.; 31B: 503-5(13 Apr 1970).

The partial muon-capture rate in ^6Li is calculated using the latest inelastic electron scattering with special emphasis on the use of PCAC. The calculated rate with the Gell-Mann–Lévy version of PCAC is in excellent agreement with experiment. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 24215, 24220, 24230, 24497, 24510, 24514, 24515, 24551, 24565, 24603, 24620, 24632, 24635, and 24658.

24519 (ORNL-4469) TABULATED CROSS SECTIONS FOR HYDROGEN AND HELIUM PARTICLES PRODUCED BY 62-, 39-, AND 29-MeV PROTONS ON ^{54}Fe. Bertrand, F. E.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 76p. Dep. CFSTI.

Tabulated differential cross sections are presented for the production of protons, deuterons, tritons, helium-3, and alpha particles from ^{54}Fe bombarded by 62-, 39-, and 29-MeV protons. Continuum differential cross sections are listed at 20 angles for 62-MeV, 7 angles for 39-MeV, and 5 angles for 29-MeV incident protons. The low-energy cutoffs on the spectra range from 1.5 to 6 MeV for the different particle types. Angular distributions are given for excitation, by 62 MeV protons, of states at 0.0, 1.41, 2.55, 2.97, 3.3, 3.84, 4.28, 4.60, 4.81, 6.38, 7.25, 8.02, and 8.52 MeV in ^{54}Fe, and at 0.0, 0.76, 1.39, 2.85, 2.99, 3.38, 3.58, 4.28, and 7.34 MeV in ^{53}Fe. Levels in ^{53}Fe at 0.0, 0.85, 4.43, 5.37, 6.1, 6.44, and 8.59 MeV were observed; however, no angular distributions are presented for these levels. (auth)

24520 (RHEL/R-187) FINAL P.L.A. PROGRESS REPORT, 1969. Batty, C. J. (ed.) (Rutherford High Energy Lab., Chilton (England)). Dec 1969. 148p. Dep. CFSTI (U. S. Sales Only). UK 1 Pound.

A survey is presented of the work of the Proton Linear Accelerator Group at the Rutherford Laboratory during 1969, the final year of operation of the machine, which was shut down on Oct. 3rd, 1969. Details are given of machine operation, proton scattering experiments, studies on proton induced reactions, theoretical studies on particle physics, experimental techniques, and health physics considerations. A list of publications by the staff is included. (UK)

24521 THE $^{40}Ar(^3He,d)^{41}K$ REACTION AT 10 MeV. Lankford, William Fleet. Columbia, S. C.; Univ. of South Carolina (1969). 89p.

Thesis.

A 5-MeV Van de Graaff accelerator was used to bombard a ^{40}Ar gaseous target with 10-MeV doubly charged ^3He ions. Deuteron spectra were obtained at angles from 13 to 160° and the absolute differential cross sections were determined. The energy level structure of ^{41}K was resolved up to an excitation of 7.6 MeV. Strong levels at 4.30, 4.53, 6.02, and 6.57 MeV were observed in addition to those levels below 3.2 MeV previously reported. Angular distributions were obtained for the 12 well resolved spectral peaks and compared to those predicted by distorted wave Born approximation calculations. The spectroscopic factors were extracted from the experimental and calculated differential cross sections. The spectroscopic factors were generally much less than unity indicating considerable mixing among the possible configurations. The theoretical basis for the $^{40}Ar(^3He,d)^{41}K$ reaction is discussed in terms of the semi-classical approach suggested by Butler and the predictions for the ground state transition are indicated. The reaction mechanism is discussed with respect to both the compound nucleus formation and to the direct reaction process. Arguments for the dominance of the direct reaction are offered and the prediction that the reaction occurred primarily on the nuclear surface is substantiated. In line with the current emphasis on isobaric spin effects in nuclear structure, the 1.31 MeV, $f^7/2$ level was identified as the T< configuration state in ^{41}K. The position of the T> analog of the ^{41}Ar ground state was calculated and the splitting between the T> and the T< states was compared to the theoretical predictions of French and MacFarlane and to the observed splittings in other nuclei. (Diss. Abstr.)

24522 STRUCTURE IN TOTAL (n,α) CROSS SECTIONS AROUND 14 MeV. Warnock, Maureen Ann. Chicago; Illinois Inst. of Tech. (1969). 168p.

Thesis.

Excitation functions for the $^{27}Al(n,\alpha)^{24}Na$ and $^{75}As(n,\alpha)^{72}Ga$ reactions were measured in steps of 15 to 20 keV throughout most of the energy range between 13.46 to 14.91 MeV in an effort to observe structure in these cross sections. A total of 635 cross section measurements were made for the $^{27}Al(n,\alpha)$ reaction at about 87 different neutron energies during 19 different irradiations. The first 185 cross section determinations were made by following the beta activity of the ^{24}Na product. The remainder of the measurements were carried out by observing the gamma-ray activity of ^{24}Na under the 1.37-MeV photo-peak. The data were corrected for the effects of anisotropy and scattering using correction factors obtained experimentally by measuring the neutron intensity at various angles from the deuteron beam direction with the employment of proton recoil telescopes. The data from all of the runs were correlated, and the resultant excitation function showed definite structure with peak widths ranging from 65 to about 200 keV and with fluctuations of a couple percent from the average cross section. The neutron energy resolution was calculated to range from 65 to about 200 keV, and the over-all precision error in determining the relative cross sections was calculated to be 0.92%. An analysis of the excitation function according to the methods of Ericson yielded, aside from finite range of data effects and resolution effects, a value consistent with that predicted by Ericson fluctuation theory for the average ^{29}Al compound nucleus level width and for the magnitudes of the peaks in the structure. A total of 200 cross section determinations were made

for the $^{75}As(n,\alpha)$ reaction at about 71 different neutron energies during 11 different irradiations. The gamma-ray activity under the 0.84-MeV photo-peak of ^{72}Ga was determined by use of a computer program. The data were corrected for anisotropy and scattering effects and the resulting relative cross sections from the various irradiations were correlated. The excitation function obtained in this case showed little evidence of the structure that could possibly be related to doorway states. The over-all error for the excitation function determination in this case was about 2 percent, however. An additional two irradiations, using an improved technique in sample preparation, yielded 40 cross section values with exceptionally high precision. Some structure around 14.5 and 14.8 MeV was evident in these measurements and would warrant additional work to confirm the presence of such structure. (Diss. Abstr.)

24523 INELASTIC PROTON SCATTERING AT 40 MeV FROM EVEN NICKEL ISOTOPES. Thompson, Kenneth Marvin. East Lansing, Mich.; Michigan State Univ. (1969). 301p.

Thesis.

A study of inelastic scattering from the even nickel isotopes was done using 40-MeV protons. Angular distributions from about 15 to 90° were obtained for each nucleus in 5° steps using Ge(Li) charged particle detectors. The best energy resolution achieved was 45 keV. A high precision goniometer was designed and constructed to facilitate the use of Ge(Li) detectors. The experimental angular distributions for all of the observed states were compared with calculated distributions using a collective model distorted wave theory. From these comparisons values for the nuclear deformation parameters, β_L, were obtained. The resulting nuclear deformations, $\beta_L R_0$, were used to calculate the vibrational model parameters and the reduced transition probabilities. The fractional depletion of an energy weighted sum rule and a sum rule based on the shell-model were also calculated for each state. The dependence of the reduced transition probabilities and sum rule limits on the model used for the nuclear charge density was also examined. Comparisons of the calculated quantities were made with results of experimental studies of electromagnetic transitions in the nickel isotopes. There were also comparisons made with the results of calculations using strongly admixed spherical shell model configurations done by N. Auerbach and a modified Tamm–Dancoff approximation done by Ram Raj et al. (Diss. Abstr.)

24524 ISOSPIN-FORBIDDEN DECAY PROPERTIES OF THE LOWEST T = 2 STATES OF ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, AND ^{40}Ca. McGrath, Robert L. (State Univ. of New York, Stony Brook); Cerny, Joseph; Hardy, J. C.; Goth, G.; Arima, Akito. Phys. Rev., C; 1: 184-92(Jan 1970).

The lowest T = 2 states of ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, and ^{40}Ca were formed using the (p,t) reaction. The isospin-forbidden proton ($\Delta T = 1$ or 2) and α-particle ($\Delta T = 2$) decay modes of these states were determined by counting triton-proton and triton-α coincidence events. The major decay modes of the states are $^{20}Ne(\alpha_1 + \alpha_2, \alpha_3 + \alpha_4)$, $^{24}Mg(p_0)$, $^{28}Si(\alpha_0)$, $^{32}S(p_0)$, $^{40}Ca(\alpha_0)$. Simple Coulomb calculations were performed for ^{40}Ca; these assumed pure shell-model configurations and considered isospin mixing in only the (1d, 1f) shells. They did not predict the relatively large $\Delta T = 2$ isospin impurities necessary to explain the observed α-particle decay. (auth)

24525 BETA DECAY OF ^{21}F. Harris, W. R.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 180-3(Jan 1970).

The β decay of ^{21}F was investigated, utilizing the $^{19}F(t,p)^{21}F$ reaction to form the ^{21}F activity and a 1.3-MeV mechanically-chopped beam. The existence of previously reported β branches to the ground and first two excited states of ^{21}Ne was confirmed, and an upper limit for decay to the third excited state of ^{21}Ne has been established by detecting β-γ coincidences and β-ray singles with NaI (Tl) and plastic scintillation detectors. The ^{21}Ne levels in keV, ^{21}F β branches populating these levels in percent, and corresponding log ft values are 0.0, 29 ± 6, 5.23 ± 0.10; 350, 63 ± 6, 4.76 ± 0.05; 1746, 7.6 ± 1.0, 5.07 ± 0.07. The log ft values measured in the present work differ markedly from those previously reported. Measurements of the excitation energies of the first two excited states of ^{21}Ne yielded (in keV) 350.5 ± 0.3 and 1745.6 ± 0.4, respectively. The upper limit on the percent branch to the third excited state is 0.15%, corresponding to a limit on the log ft of 6.0. (auth)

24526 NEUTRON SCATTERING WITH AN INITIAL ENERGY OF 2.9 MeV BY TITANIUM AND CHROMIUM NUCLEI. Paschnik, M. V.; Fedorov, M. B.; Yakovenko, T. I.; Kashuba, I. E.; Korzh, I. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 14: 1874-8(Nov 1969). (In Russian).

The differential cross sections of the elastic scattering of 2.9-MeV neutrons by Cr and Ti nuclei and the differential cross sections of inelastic neutrons with excitement of the first 2^+ levels were measured by the time-of-flight method. The experimental results were compared with the calculations made by the Hauser–Feshbach statistic theory and an optical model basis. (auth)

24527 THE THERMAL NEUTRON CAPTURE CROSS SECTION AND RESONANCE CAPTURE INTEGRAL OF ^{35}Cl FOR (n,gamma) AND (n,p) REACTIONS. Sims, G. H. E.; Juhnke, D. G. (Atomic Energy of Canada Ltd., Ottawa). J. Inorg. Nucl. Chem.; 31: 3721-5 (Dec 1969).

The effective neutron capture cross section of ^{35}Cl for (n,γ) and (n,p) reactions was measured by the activation method. By irradiating samples in a reactor with and without a cadmium cover and by assuming a 1/v dependence in the sub-cadmium region, the 2200 m/sec cross sections and the resonance integrals for both reactions were calculated using the Westcott convention. The values found for the (n,γ) reaction are $\sigma_0 = 41.8 \pm 1.2$ barns and $\Sigma = <20$ barns. For the (n,p) reaction $\sigma_0 = 0.492 \pm 0.014$ barns and $\Sigma = 0.369 \pm 0.015$ barns. All measurements are relative to a ^{59}Co cross section of 37.5 barns and resonance integral of 69.9 barns. (auth) (UK)

24528 NUCLEAR-STRUCTURE CALCULATIONS FOR ^{52}Cr AND EVEN Ni ISOTOPES. Roy, B. Barman; Raj, Ram; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 1: 207-14(Jan 1970).

Employing ^{48}Ca and ^{56}Ni as cores for ^{52}Cr and ^{60}Ni, respectively, the shell-model properties of these nuclei are described using the renormalized reaction matrix elements of the Hamada–Johnston nucleon-nucleon potential. For ^{52}Cr, the seniorities 2 and 4 of the $f_{\frac{7}{2}}^4$ configuration are mixed through intermediate states of other configurations in an attempt to explain the branching ratios from J = 6 and J = 5 levels to the low-lying J = 4 levels; and also the effect of increasing the configuration space is explicitly studied. A qualitative agreement between the calculated and experimental spectra is found, and the wave functions thus obtained are not found to be suitable for the description of transition rates. For ^{60}Ni, the effect of including the additional $g_{\frac{9}{2}}$ orbital is also investigated. The calculated energy levels agree fairly well with the experimental levels, but the wave functions do not provide a satisfactory explanation for the observed transition rates. The even Ni isotopes are then described in the framework of the modified Tamm–Dancoff approximation (MTDA). The agreement for the energy levels for ^{60}Ni between the shell-model and the MTDA results is of the same quality, but the MTDA result indeed shows an improvement over the shell-model results in describing the vibrational characteristic of the second excited 2^+ state. The MTDA results for Ni isotopes appear to be fairly satisfactory. (auth)

24529 . PRODUCTION OF ^{18}F, ^{22}Na, AND ^{24}Na FROM SEPARATED ISOTOPES OF THE LIGHT ELEMENTS WITH 300- AND 400-MeV PROTONS. Korteling, Ralph R. (Carnegie-Mellon Univ., Pittsburgh. Simon Fraser Univ., Burnaby, British Columbia); Caretto, Albert A. Jr. Phys. Rev., C; 1: 193-201(Jan 1970).

Cross sections for the production of ^{18}F, ^{22}Na, and ^{24}Na were determined from the separated isotopes of magnesium, silicon, and sulfur, using 300- and 400-MeV protons. These values, together with previous measurements, provide data for targets of each mass number of 23 to 34 inclusive for ^{18}F and ^{22}Na and from 25 to 34 inclusive for ^{24}Na. The main feature of the results is that the cross section is highest for those targets having the N/Z closest to that of the products. Thus, events involving the loss of about the same number of neutrons as protons have the highest probability. Cascade-evaporation calculations were performed for 400-MeV protons on each of these nuclides. The calculations reproduce the experimental trends. (auth)

24530 THEORETICAL INVESTIGATION OF THE PROPERTIES OF THE ODD-A NUCLEI FROM A = 27 TO 35 IN THE UNIFIED NUCLEAR MODEL. Bailey, Frank George. Brooklyn; Polytechnic Inst. of Brooklyn (1969). 146p.

Thesis.

The present theoretical investigation is an attempt to account for a number of experimentally observed properties of the low-lying levels in ^{27}Mg, ^{29}Si, ^{29}P, ^{31}P, ^{33}S, ^{33}Cl, and ^{35}Cl using the intermediate coupling approach in the unified nuclear model. For this purpose one describes each odd-mass nucleus in terms of the neighboring doubly even nucleus plus the last odd nucleon described by shell model single-particle states. Since the excited states of the doubly even nuclei show vibrational character, it is assumed that each odd-mass nucleus is a coupled system consisting of a doubly even core susceptible to quadrupole vibrations of the same frequency as the corresponding doubly even nucleus, plus the last odd nucleon which has available to it both the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ states. There are three parameters which enter into the calculations. The first is the phonon energy $\hbar\omega$, associated with the collective sur-

face vibrations of the core. The value of $\hbar\omega$ is taken to be the energy of the first excited state of the neighboring doubly even nucleus. The second parameter ϵ is the effective spacing in energy between the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ states. This is regarded as an adjustable parameter. The third parameter ξ is the coupling strength between the odd nucleon and the core vibrations. It is varied within reasonable limits to obtain the best fit to the experimental data. The Hamiltonian matrix is diagonalized in the space of the uncoupled system for values of spin from $\frac{1}{2}$ to $\frac{7}{2}$. Using physically reasonable values of the parameters, the energies, spins, and parities of the low-lying states are calculated for the nuclei considered. The theoretical results are in reasonably good agreement with the available experimental data. In addition to the energy levels, the nuclear moments and electromagnetic transition probabilities were calculated using the eigenfunctions obtained from the diagonalization of the Hamiltonian matrices. In both of these calculations an effective charge and an effective spin gyromagnetic ratio were assigned to the last odd nucleon to account for polarization in a phenomenological way as has been done by others. The improved agreement between theory and experiment resulting from this seems to indicate that core polarization effects are indeed rather important in these nuclei. The agreement between the theoretical and experimental values of the nuclear moments is quite good. Although the agreement, in the case of the electromagnetic transition probabilities, is not spectacular, it is rather good, particularly considering the fact that these results are strongly dependent on the amount of mixing and the values chosen for the parameters. (Diss. Abstr. Int., B)

24531 SPIN AND PARITY ASSIGNMENT FOR THE 872-keV LEVEL IN ^{69}Ga. Raman, Subramanian; Couch, Richard G. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 1: 744-6(Feb 1970).

The decays of 58-min ^{69g}Zn and 14-h ^{69m}Zn were investigated with a 30-cm^3 Ge(Li) detector. In addition to the 438.6-keV isomeric transition in ^{69}Zn, γ rays of energies 318.6, 574.3, and 872.5 keV were observed. These γ rays were incorporated into the known level scheme of ^{69}Ga. The studies show that the β^- feeding to the 872-keV level in ^{69}Ga is from the $\frac{1}{2}^-$, ^{69}Zn ground state and not from the $\frac{9}{2}^+$, ^{69}Zn metastable state as has been reported. The present results are consistent with a $\frac{1}{2}^-$ assignment for the 872-keV level. (auth)

24532 STROBOSCOPIC OBSERVATION OF NUCLEAR LARMOR PRECESSION. Christiansen, J.; Mahnke, H.-E.; Recknagel, E.; Riegel, D.; Schatz, G.; Weyer, G.; Witthuhn, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Rev., C; 1: 613-18(Feb 1970).

A new resonance method is described which is suited for the measurement of hyperfine interactions at nuclear isomers with mean lives longer than 1 μsec. The method is characterized by pulsed-beam production of excited nuclei, the Larmor frequency of which is determined by a coherent superposition of the perturbed angular correlation originating from different beam pulses. An experiment was performed on a 4-μsec state of ^{69}Ge. The g factor was determined as $g = -0.2224 \pm 0.0007$. (auth)

24533 STUDY OF THE LOW-LYING $T = \frac{1}{2}$ STATES IN ^{21}Na. Bearse, R. C. (Argonne National Lab., Ill.); Legge, J. C.; Morrison, G. C.; Segel, R. E. Phys. Rev., C; 1: 608-12(Feb 1970).

The γ decays of the two lowest $T = \frac{1}{2}$ states in ^{21}Na at 8.97 and 9.22 MeV were studied as resonances in the ^{20}Ne(p,γ) reaction by use of a gas cell and a 30-cc Ge(Li) detector. For the lower resonance, three branches were found: to the $\frac{3}{2}^+$ ground state (11%), to the $\frac{1}{2}^+$ first excited state (50%), and to the $\frac{1}{2}^+$ second excited state (39%). These results imply that $J = \frac{1}{2}^+$ for the $T = \frac{1}{2}$ state. On the simple rotational model, transitions from states of the $K = \frac{1}{2}$ (Nilsson orbit #6) band are possible only to the ground-state $K = \frac{1}{2}$ (#7) band. A $J = \frac{1}{2}^+$, $K = \frac{1}{2}$ assignment for the lowest $T = \frac{1}{2}$ state fits the observed branching ratios. The second resonance decays predominantly to the ground state, and there is at most a 9% branch to the $\frac{1}{2}^+$ state at 2.41 MeV. The second resonance is assigned $J = \frac{1}{2}^+$, $K = \frac{1}{2}$. If the 2.41-MeV state is $K = \frac{1}{2}$ (#9), no transition to it is expected. On both resonances, transitions to higher excited states are obscured by background. (auth)

24534 ALPHA–GAMMA ANGULAR CORRELATIONS IN THE ^{40}Ca(^{3}He,$\alpha\gamma$)^{39}Ca REACTION. Balamuth, D. P.; Zurmuehle, R. W.; Anastassiou, G. P.; Gould, C. R.; Fou, C. M. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 1: 470-6(Feb. 1970).

Angular correlations of γ rays leading to states in ^{39}Ca at 2.47 2.80, 3.03, 3.66, 3.95, and 4.02 MeV were measured. The spins and parities of the first three excited states were found to be $\frac{1}{2}^+$, $\frac{1}{2}^-$, and $\frac{3}{2}^-$, in agreement with previous work. The mixing ratio determined for the 2.80 $\rightarrow$ g.s. transition implies 98% M2, in disagreement with an earlier measurement. In conjunction with l-value assignments from distorted-wave Born-approximation analysis of charged-particle angular distributions, the present work assigns $J^\pi = \frac{3}{2}^-$ for the 3.66-MeV state, $\frac{3}{2}^-$ for the 3.95-MeV state, and $\frac{1}{2}^+$ for the 4.02-MeV state. Multipole mixing and branching ratios were extracted from the data. (auth)

24535 PROTON POLARIZATION IN THE ^{28}Si(d,p)^{29}Si REACTION. Maddox, W. E.; Kelley, C. T. Jr.; Miller, D. W. (Indiana Univ., Bloomington). Phys. Rev., C; 1: 476-87(Feb 1970).

The polarizations of protons from the ^{28}Si(d,p)^{29}Si reactions leading to the ground state and the 1.28-, 2.03-, and 3.62-MeV excited states of ^{29}Si were measured over the range of laboratory angles from 30 to 147° at a bombarding deuteron energy of 10.8 MeV. A scattering-chamber-polarimeter assembly employing solid-state detectors was used to allow the measurements on all groups to be made simultaneously. To provide additional data for theoretical comparisons, the differential cross sections for the same reactions and for the elastic scattering of deuterons from ^{28}Si have also been measured at the same bombarding energy. For the $l_n = 0$ ground-state reaction, the observed polarizations change rapidly from large negative to large positive values near the minima in the cross section at 50 and 90°. The 1.28-MeV excited-state reaction also shows large polarizations, but with no obvious relationship to variations in the cross section. Polarizations of protons corresponding to the 2.03- and 3.62-MeV excited states are smaller (between ±0.3) and appear to be uncorrelated with cross-section variations. Comparisons are made with published theoretical predictions where available. (auth)

24536 PROTON POLARIZATION IN THE REACTION ^{40}Ca(d,p)^{41}Ca. Kelley, C. T. Jr.; Maddox, W. E.; Miller, D. W. (Indiana Univ., Bloomington). Phys. Rev., C; 1: 488-95(Feb 1970).

The polarizations of protons from the reactions ^{40}Ca(d,p)^{41}Ca leading to the ground state and the 1.95- and 2.47-MeV excited states of ^{41}Ca have been measured at 13 angles between 30 and 148° in the laboratory system at a bombarding energy $E_d = 10.8$ MeV. A carbon polarimeter using solid-state detectors permitted the measurements for all three proton groups to be made simultaneously. The polarization results for the $l_n = 3$, $j_n = \frac{7}{2}$ ground-state reactions are in good agreement with previous measurements, but extend to larger angles. Shapes of the polarization angular distributions for protons from the $l_n = 1$, $j_n = \frac{3}{2}$ reactions exciting the 1.95- and 2.47-MeV states are very similar to each other except possibly near 100°. Comparisons are made with available theoretical predictions for these reactions. (auth)

24537 LEVEL STRUCTURE OF ^{48}Sc FROM THE ^{48}Ca(^{3}He,t) REACTION. Ohnuma, H.; Erskine, J. R.; Schiffer, J. P.; Nolen, J. A. Jr.; Williams, Norman (Argonne National Lab., Ill.). Phys. Rev., C; 1: 496-501(Feb 1970).

The ^{48}Ca(^{3}He,t)^{48}Sc reaction was studied with a magnetic spectrograph at a bombarding energy of 15 MeV. Energy levels of ^{48}Sc were obtained and compared with the results of previous work. From consideration of cross sections, angular distributions, and previous spin and parity assignments, eight levels of ^{48}Sc are tentatively assigned to the $(\pi f_{\frac{7}{2}}^{-1})(\nu f_{\frac{7}{2}}^{-1})$ configuration—namely, those with $J^\pi = 0^+$, $E_x = 6.680$; 1^+, 2.525; 2^+, 1.145; 3^+, 0.624; 4^+, 0.253; 5^+, 0.133; 6^+, 0; and 7^+, 1.096 MeV. These states are populated roughly an order of magnitude more strongly than the other states in ^{48}Sc. (auth)

24538 INVESTIGATION OF ^{46}Sc BY THE REACTION ^{47}Ti(d,^{3}He)^{46}Sc. Lewis, M. B. (Univ. of Pittsburgh). Phys. Rev., C; 1: 501-6(Feb 1970).

Angular distributions from the ^{47}Ti(d,^{3}He)^{46}Sc and ^{48}Ti(d,^{3}He)^{46}Sc reactions were measured with a deuteron beam energy of 17 MeV. The ^{3}He particles were magnetically analyzed by position-sensitive counters and photographic emulsions mounted in an Enge split-pole spectrograph with typical experimental resolutions of 8-10 keV full width at half-maximum. With the use of distorted-wave Born-approximation calculations for $2s_{\frac{1}{2}}$, $1d_{\frac{3}{2}}$, $1f_{\frac{7}{2}}$, and 2p pickup, l_p values and spectroscopic factors were deduced. The results verify a finite (≈0.2 protons) occupation in the 2p orbitals. In addition, the $1f_{\frac{7}{2}}$ orbit appears in slight excess and $1d_{\frac{3}{2}}$ is slightly deficient in its shell-model value of protons. By comparison with other studies in ^{46}Sc, it is concluded that the similar average binding energies for $\pi f_{\frac{7}{2}}\nu(f_{\frac{7}{2}})_{\frac{7}{2}}$, $\pi f_{\frac{7}{2}}\nu(f_{\frac{7}{2}})_{\frac{3}{2}}$, and $\pi(d_{\frac{3}{2}}^{-1})(f_{\frac{7}{2}})_0\nu(f_{\frac{7}{2}})_{\frac{7}{2}}$ configurations are primarily responsible for the high level density and large configuration mixing in the 0–1-MeV excitation in ^{46}Sc. In the 1–2-MeV region, the $\pi(s_{\frac{1}{2}}^{-1})(f_{\frac{7}{2}})_0\nu(f_{\frac{7}{2}})_{\frac{7}{2}}$, $\pi d_{\frac{3}{2}}^{-1}(f_{\frac{7}{2}})_0\nu(f_{\frac{7}{2}})_{\frac{7}{2}}$, $\pi d_{\frac{3}{2}}^{-1}(f_{\frac{7}{2}})_0\nu d_{\frac{3}{2}}^{-1}(f_{\frac{7}{2}})_0$, and $\pi f_{\frac{7}{2}}\nu(f_{\frac{7}{2}})_0 2p^1$ configurations dominate the spectrum. (auth)

24539 NUCLEAR STRUCTURE OF ^{43}Sc. II. GAMMA-RAY ANGULAR CORRELATIONS. Manthuruthil, J. Ç.; Poirier, C. P.; Walinga, J. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., C; 1: 507-22(Feb 1970).

The spin and multipolarity mixing ratios of five resonances and many bound states in ^{43}Sc were determined from angular-

correlation and linear-polarization measurements. Unique spin assignments were made for the following levels: 0.846 MeV ($\frac{5}{2}$), 0.856 MeV ($\frac{1}{2}$), 1.158 MeV ($\frac{3}{2}$), 1.179 MeV ($\frac{3}{2}$), 1.652 MeV ($\frac{5}{2}$), 1.963 MeV ($\frac{5}{2}$), 2.094 MeV ($\frac{3}{2}$), 2.143 MeV ($\frac{7}{2}$), and 2.580 MeV ($\frac{5}{2}$). In addition, limitations on the possible spin assignments were made for the following levels: 1.885 MeV ($\frac{5}{2}$, $\frac{9}{2}$), 2.383 MeV ($\frac{3}{2}$, $\frac{7}{2}$), 2.986 MeV ($\frac{3}{2}$, $\frac{5}{2}$), 3.289 MeV ($\frac{3}{2}$, $\frac{5}{2}$), and 4.455 MeV ($\frac{5}{2}$, $\frac{9}{2}$). The parity of the 0.846-MeV level was found to be negative from linear-polarization measurements. These results, together with results due to other investigators, are discussed in terms of various nuclear models. It is shown that neither the shell model nor the cluster model can account for the observed properties of ^{43}Sc. The Coriolis-coupling model gives reasonable qualitative agreement, but quantitative agreement with experiment will require a modification of the model. Johnstone's model successfully accounts for the observed properties of all levels except for those levels identified as belonging to the $K^\pi = \frac{1}{2}^+$ band. Specific experiments are suggested to determine the nature of these states. (auth)

24540 ELASTIC SCATTERING OF ALPHA PARTICLES BY INTERMEDIATE-MASS NUCLEI. Fernandez, B.; Blair, J. S. (Univ. of Washington, Seattle). Phys. Rev., C; 1: 523-38 (Feb 1970).

Angular distributions of 42-MeV α particles, elastically scattered from ^{40,42,44,48}Ca, ^{46,48,50}Ti, ^{52}Cr, ^{54,56}Fe, ^{58,60,62}Ni were measured in the forward region with an absolute accuracy of ±0.1°; in particular, the locations of the minima near 35° (c.m. system) were determined to within ±0.1°. The theoretical analysis was done in three ways, using (a) the Fraunhofer model, (b) a direct parametrization of the scattering amplitude in terms of three parameters, and (c) a standard four-parameter optical model. Strong-absorption radii were deduced from the critical angular momenta extracted from the scattering amplitudes. In addition, attempts were made to determine, for the optical-model analysis, other sorts of strong-absorption radii that are more characteristic of the scattering than the usual midpoint radius of the potential. The analyses indicate that the rate of increase of almost all such strong-absorption radii is smaller within the Ca and Ti isotopes than within the Fe and Ni isotopes, the radius of ^{43}Ca being anomalously small for all types of analysis. (auth)

24541 PARAMETRIZATION OF ENERGY-AVERAGED AND FINE-ENERGY-RESOLUTION CROSS SECTIONS FOR THE ^{40}Ca $(\alpha,\alpha_0)^{40}$Ca REACTION 5.5 TO 17.5 MeV. Bisson, A. E.; Eberhard, K. A.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., C; 1: 539-47(Feb 1970).

The description of energy-averaged angular distributions for the ^{40}Ca$(\alpha,\alpha_0)^{40}$Ca reaction from 5.5 to 17.5 MeV as the incoherent sum of an l-dependent-absorption optical-model cross section and a Hauser–Feshbach compound-elastic-scattering cross section is discussed. The parameters for both cross sections are determined throughout the energy range. Statistical-model calculations of the Hauser–Feshbach parameters ρ and σ are in good agreement with those extracted from the data. The compound-elastic-scattering cross sections obtained by analyzing the energy-averaged angular distributions are compared with those obtained in an Ericson fluctuation analysis of the fine-resolution excitation curves. (auth)

24542 T = 2 AND T = 3 ANALOG STATES, $28 \leq A \leq 40$. Hardy, J. C.; Brunnader, H.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev., C; 1: 561-9(Feb 1970).

The simultaneous observation of (p,t) and (p,^{3}He) reactions has led to the location and identification of the lowest-energy (0^+) T = 2 states in ^{28}Al, ^{28}Si, ^{32}P, ^{32}S, ^{36}Cl, ^{36}Ar, ^{40}K, and ^{40}Ca, as well as the (0^+) T = 3 states in ^{36}Cl and ^{36}Ar. The energies of these states are used to predict the masses of six neutron-deficient nuclei: ^{28}S, ^{32}Ar, ^{36}Ca, ^{38}Sc, ^{38}Ti, and ^{40}Ti. In addition, the (p,t) cross section for production of each analog state relative to the cross section for producing the ground state in the same nucleus is compared with calculations which assume a simple shell model. Good agreement is obtained. (auth)

24543 INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES BY ^{25}Mg. Blair, J. S.; Naqib, I. M. (Univ. of Washington, Seattle). Phys. Rev., C; 1: 569-80(Feb 1970).

Cross sections were measured for elastic and inelastic scattering of 42-MeV α particles by ^{25}Mg in the range θ(lab) = 10 to 60°. Six inelastic α groups were identified at the following measured –Q values: 1.59, 1.94, 2.55, 2.75 (doublet), 3.400 (doublet), and 4.05 MeV. The cross sections are analyzed in terms of the distorted-wave Born-approximation version of the extended optical model and the smoothed Fraunhofer inelastic diffraction model. A general discussion is given of the transition strengths of odd-mass nuclei within the context of the strong-coupling rotational model or modifications thereof, and application is made to the present results. The main conclusions are: Inelastic scattering within the ground-state band supports the rotational model in its simplest form. Comparison of the elastic cross sections from ^{24}Mg, ^{25}Mg, and ^{26}Mg indicates the presence of a quadrupole contribution to the elastic section from ^{25}Mg, consistent with the strong-coupling prediction. The $\lambda = 2$ single-nucleon contribution to transitions into the lowest $K = \frac{1}{2}^+$ band appears to be very small. The excitation corresponding to the known level at 4.057 MeV suggests that this level arises from coupling a γ vibration to the ground-state band. The second $K = \frac{1}{2}^+$ band may have the same origin, although other evidence indicates that there is at least a sizable admixture of a single-nucleon orbital to this band. (auth)

24544 FAST NEUTRONS INCIDENT ON VANADIUM. Smith, A. B.; Whalen, J. F.; Takeuchi, K. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 581-93(Feb 1970).

Total neutron cross sections and elastic and inelastic neutron-scattering cross sections of vanadium are experimentally studied. Total neutron cross sections are determined with good resolution (≤1 keV) from 0.1 to 1.45 MeV. Differential elastic and inelastic scattering angular distributions are measured at incident-neutron energy intervals of ≤10 keV and with resolutions of ~20 keV from 0.3 to 1.5 MeV. The inelastic excitation of states at 330 ± 10 and 926 ± 10 keV is observed. The experimental results are interpreted in terms of the optical model and statistical concepts inclusive of resonance-width fluctuations. The observed intermediate structure is discussed in the context of strongly overlapping resonances, distributions in resonance widths and spacing, and an intermediate optical model. (auth)

24545 PERSISTENCE OF ODD–EVEN EFFECT ON NUCLEAR LEVEL DENSITIES AT HIGH EXCITATION ENERGY. Katsanos, A. A.; Shaw, R. W. Jr.; Vandenbosch, R.; Chamberlin, D. (Univ. of Washington, Seattle). Phys. Rev., C; 1: 594-601(Feb 1970).

Excitation functions and angular distributions for the reaction ^{54}Cr(p,α)^{51}V were measured between 6.5 and 20.0 MeV for the ground state and the first two excited states in ^{51}V at 0.32 and 0.92 MeV, with spins $\frac{7}{2}^-$, $\frac{5}{2}^-$, and $\frac{3}{2}^-$, respectively. From the angular distributions and the excitation functions, a compound nuclear mechanism is supported for the population of the $\frac{5}{2}^-$ and $\frac{3}{2}^-$ levels. At higher bombarding energies there is evidence that a simple pickup mechanism dominates for producing the $\frac{7}{2}^-$ level. From the fluctuation analysis of the excitation functions for the $\frac{5}{2}^-$ and $\frac{3}{2}^-$ levels, the decay width of the compound nucleus ^{55}Mn was obtained as a function of energy. From the differential cross sections and decay widths, the level density of ^{55}Mn was deduced at excitation energies between 15 and 23 MeV. The results were combined with low-energy level-density data previously obtained with a magnetic spectrograph. These results, when compared with similar data for even-even ^{56}Fe, show that the energy shift required to match level densities for odd and even nuclei is the same at low and high excitation energies. The energy dependence of the level density cannot be reproduced over the whole energy range with level-density expressions employing conventional odd-even corrections. The same conclusion is supported by statistical-model calculations of the excitation functions. (auth)

24546 MEAN LIVES OF SOME STATES IN ^{31}Si BELOW 3.54-MeV. Wozniak, M. J. Jr.; Donahue, D. J. (Univ. of Arizona, Tucson). Phys. Rev., C; 1: 601-7(Feb 1970).

A Ge(Li) detector and the reaction ^{30}Si(d,p)^{31}Si with E_d = 2 to 4 MeV are used in the coincidence version of the Doppler-shift attenuation method to obtain the following information concerning the mean lives of some low-lying states in ^{31}Si: τ(0.75 MeV) = $(7.2) \times 10^{-13}$ sec, τ(1.69 MeV) = $(7.4 \pm 2.3) \times 10^{-13}$ sec, τ(2.32 MeV) < 3×10^{-13} sec, τ(3.14 MeV) = $(5.0) \times 10^{-13}$ sec, τ(3.53 MeV) < 3.7×10^{-14} sec. From these results, the reduced matrix elements for electromagnetic transitions among some of these states are obtained. A comparison is made between these reduced matrix elements and those predicted by the extreme single-particle model, the Nilsson rotational model, and the shell model with configuration mixing in the $2s_{\frac{1}{2}}$ and $1d_{\frac{3}{2}}$ shells. The results indicate a value of $|\eta| = 2.8$ for the Nilsson deformation parameter for ^{31}Si. A value of 752 ± 1 keV was obtained for the excitation energy of the 0.75-MeV state. (auth)

24547 SEARCH FOR DIRECT NEUTRON CAPTURE IN ^{63}Cu, ^{59}Co, AND ^{55}Mn USING A Ge(Li) DETECTOR. Auchampaugh, George Frederick. Davis, Calif.; Univ. of California (1968). 107p.

Thesis.

The direct mechanism in the neutron radiative capture reaction was studied by the direct-resonance interference technique in ^{63}Cu, ^{59}Co, and ^{55}Mn. An 18 cc Ge(Li) detector was used to measure the intensity of 5 transitions in copper, 9 in cobalt, and 11 in manganese as a function of neutron energy. Good least square fits to some of these data were achieved by requiring the following values of direct capture cross section at 1 eV neutron energy for the

transitions in parenthesis: ^{63}Cu, 2.7 ± 1.5 mb (7.914 MeV), 8.1 ± 7.6 mb (7.303 MeV); ^{59}Co, 5.5 ± 1.5 mb (7.495 MeV). In manganese no positive statement could be made about the magnitude of the direct capture cross section for the three transitions studied in detail, namely the 7.150-, 7.047-, and 5.054-MeV transitions. All other transitions studied required no direct amplitude to fit the data. Five neutron resonances which occur in natural copper below 2 keV were assigned to the ^{63}Cu isotope. These resonances occur at 405, 650, 807, 998, and 1368 eV. The 2.211-MeV state in ^{56}Mn was assigned a $J^{\pi} = 1^+$ from the absence of transitions to this state from 3^- resonance states. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 23750, 24186, 24215, 24230, 24497, 24632, 24645, 24648, and 24658.

24548 (AAEC/TM-526) PRECISE MEASUREMENTS OF THE AVERAGE KINETIC ENERGY OF FRAGMENTS IN THE FISSION OF ^{235}U BY FAST NEUTRONS. Ajitanand, N. N. (Bhabha Atomic Research Centre, Bombay (India)); Boldeman, J. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1970. 11p. Dep. CFSTI (U. S. Sales Only).

The average total kinetic energy of fragments in the fission of ^{235}U by neutrons of energies ranging from 200 to 900 keV was measured using two solid-state detectors to detect the fission fragments in coincidence. The average total kinetic energy of fragments is independent of the incident neutron energy and, within experimental error, does not show the reported discontinuity around 300 keV neutron energy. (auth)

24549 (KFK-1059) CALCULATION OF THE HALF LIVES OF UNKNOWN ISOTOPES OF THE ACTINIDES. Keller, K. A.; Muenzel, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Nov 1969. 42p. (In German). Dep. CFSTI (U. S. Sales Only).

For the prediction of partial half-lives for α-decay and electron capture, semiempirical relations were derived. By use of mean excitation energies of the daughter nuclides an improved accuracy could be obtained. The total half-lives of neutron deficient actinide isotopes, extended up to atomic number 108, were computed by means of these equations, taking into account the partial half-lives for spontaneous fission. (auth)

24550 (LA-tr-69-29) THE DE-EXCITATION OF EVEN-ODD NUCLEI NEAR THE MAGIC NUMBER N = 82 AFTER THERMAL NEUTRON CAPTURE. Groshev, L. V.; Dvoretskii, V. N.; Demidov, A. M.; Al'vash, M. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.), from report IAE-1780. 13p. Dep. CFSTI.

With an external beam of thermal neutrons, the gamma-ray spectra of even-odd nuclei of barium (^{135}Ba, ^{137}Ba, ^{139}Ba) and cerium (^{139}Ce, ^{141}Ce, ^{143}Ce) were measured with the help of a single crystal Ge(Li) spectrometer. The spectra obtained together with the γ-ray spectra of odd neodymium nuclei made it possible to discover certain regularities in the de-excitation of even-odd nuclei with neutron numbers N = 79, 81, 83, and 85, testifying to direct thermal neutron capture by even-odd nuclei in the neighborhood of the magic number N = 82. (auth)

24551 (NYO-3525-48) STUDIES OF ELECTROMAGNETIC PROPERTIES OF EXCITED STATES OF NUCLEI. Annual Progress Report, 1969. Metzger, F. R. (Bartol Research Foundation, Swarthmore, Pa.). 12 Dec 1969. Contract AT(30-1)-3525. 60p. Dep. CFSTI.

CALCIUM-44 — energy levels of, shell-model calculation for, (T)
CALCIUM-46 — energy levels of, shell-model calculation for, (T)
CALCIUM-48 — energy levels of, shell-model calculation for, (T)
CARBON-13 — energy level of, shell-model calculation of transition strength for $\frac{1}{2}^-$, (T)
LEAD-206 — energy level at 1.706 MeV from photon resonance scattering, partial width for, (E)
MANGANESE-55 — energy level at 2.564 MeV from photon resonance scattering, width for, (E)
NEODYMIUM-144 — energy level at 2.655 MeV from photon resonance scattering, spin-parity assignment for, (E)
NICKEL-60 — energy level at 1.33 MeV from cobalt-60 decay, transition probability for, (E)
NITROGEN-13 — energy level of, shell-model calculation of transition strength for $\frac{1}{2}^-$, (T)
ZINC-64 — energy levels from photon resonance scattering, spin assignment and widths for, (E)
ZINC-66 — energy levels from photon resonance scattering, spin assignments and widths for, (E) (J.W.R.)

24552 (ORNL-TM-2851(Rev.)) CROSS-SECTION AND NUCLEAR-CONSTANT DATA FOR HEAVY METAL NUCLIDES (FUELS). Kasten, Paul R.; Craven, C. W. Jr.; Wright, Richard Q. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Cross sections and nuclear constants of fissile and fertile materials and of higher isotopes are summarized in graphical form, based on ENDF/B data. The resulting figures permit visual appreciation of nuclear data in present use, and relative comparison of data for the different fissile, fertile, and higher-isotope materials. (auth)

24553 (RPI-328-186) SPIN DETERMINATION OF RESONANCES IN ^{165}Ho(n,γ) FROM LOW-LEVEL OCCUPATION PROBABILITY RATIOS. Roenitz, W. P. (Argonne National Lab., Ill.); Tatarczuk, J. R. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [1970]. 22p. Dep. CFSTI.

The dependence of the low level occupation probabilities on the compound state spin has been used to assign spin values to fourteen resonances in the reaction ^{165}Ho(n,γ) ^{166}Ho within the neutron energy range from 18 to 86 eV. The low level occupation probabilities were determined from the intensities of γ-rays deexciting these levels. These intensities have been measured in a time-of-flight experiment at the Rensselaer electron linear accelerator using a Ge(Li) detector. The spins assigned in the present experiment agree with those of the seven resonances where spin values have been recommended in BNL 325. (auth)

24554 (UUIP-662) LIFETIMES OF THE 557.3 AND 559.2 keV LEVELS IN ^{193}Ir. Vaelivaara, K. G.; Kozyczkowski, J.; Marelius, A. (Uppsala Univ. (Sweden). Inst. of Physics). Oct 1969. 10p. Dep. CFSTI (U. S. Sales Only).

The lifetimes of some excited states in ^{193}Ir were measured. The previous 558-keV level was now shown to be a close doublet. For this reason only upper limits for the lifetimes of the 557.3- and 559.2-keV levels were given resulting from a measurement of the combined decay. In this work an attempt was made to get more accurate values of the lifetimes of the two levels from a special measurement of the lifetime of the 557.3-keV level. A comparison between different investigations is made. The lifetimes of the 557.3, 559.2 keV doublet in ^{193}Ir were measured by the delayed coincidence technique. The results are: 557.3 keV level: $T_{\frac{1}{2}} = 34 \pm 8$ ps, 559.2 keV level: $T_{\frac{1}{2}} \leq 76$ ps. Furthermore, the lifetimes of two other excited states were measured. The results are: 361.8 keV level: $T_{\frac{1}{2}} = 36 \pm 7$ ps, 712.1 keV level: $T_{\frac{1}{2}} = 15 \pm 14$ ps. (auth) (Sweden)

24555 (WCAP-3845-2) DESCRIPTION OF THE GENERATION OF DATA DECKS BY ETOG-1 FOR USE IN CREATING MUFT AND GAM LIBRARIES. Kellman, S.; Kusner, D. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan 1970. Contract AT(30-1)-3845. 26p. (ENDF-133). Dep. CFSTI.

Values are listed for input parameters to ETOG-1 used in the generation of the accompanying data decks for creating MUFT-4, MUFT-5, GAM-I and GAM-II libraries. A description of required changes made to the input ENDF/B data files for the materials processed is also given. (auth)

24556 MEASUREMENT OF THE CROSS SECTION FOR THE ISOMERIC ACTIVATION OF ^{115}In BY γ RAYS FROM ^{24}Na SOURCE. Veres, A.; Lakosi, L. (Inst. of Isotopes, Budapest). Acta Phys. Acad. Sci. Hung.; 27: 19-23(1969).

The activation cross section of ^{115}In for a 150 Ci ^{24}Na source emitting 1.38- and 2.75-MeV gamma photons was determined. The value found on the basis of the induced ^{115m}In activity proved to be 13.5×10^{-32} cm^2, being about threefold of 4.9×10^{-32} cm^2, the value determined with the aid of ^{60}Co photons. This deviation gives evidence of the existence of higher, 1.42-, 2.13- and 2.63-MeV activation levels in addition to the first at 1.078 MeV, which has previously been measured when using accelerators for excitation. (auth)

24557 e⁻γ-WINKELKORRELATIONSMESSUNGEN AN KERNUEBERGAENGEN MIT ANOMALER KONVERSION. (e⁻γ Angular Correlation Measurements in Nuclear Transitions With Anomalous Conversion). Voss, Jens; Bodenstedt, Erwin. Forschungsberichte des Landes Nordrhein-Westfalen, Nr. 2099. Koeln and Opladen, Ger.; Westdeutscher Verlag (1969). 38p. (NP-18120).

Theoretical and experimental results obtained on the study of the e⁻γ angular correlations on two E1 transitions in ^{175}Lu at 283 and 145 keV and on the M1/E2 transition at 482 keV in ^{181}Ta are reported. It was possible to derive with satisfactory accuracy

the penetration matrix elements for the 283-keV transition in ^{175}Lu and for the 482-keV transition in ^{181}Ta. The theory of e$^-\gamma$ transitions is first represented and which relation exists with the penetration matrix element is shown. The experimental study of the transitions with newly constructed precision devices using four detectors was described. (J.S.R.)

24558 GAMMA RAYS FROM PRIMARY FISSION FRAGMENTS OF ^{252}Cf. Ruegsegger, Donald Ray Jr. Tempe, Ariz.; Arizona State Univ. (1969). 100p.

Thesis.

An experiment was carried out to study the gamma rays from the primary fragments produced during the spontaneous fission of ^{252}Cf. The Z values of the fragments studied were determined by detecting their characteristic K_{α} x rays with a lithium-drifted silicon x-ray spectrometer. The gamma rays were detected with a lithium-drifted germanium detector and were energy analyzed by a 1024 channel analyzer. Gamma rays were observed from three primary fission elements, lanthanum, cerium, and praseodymium, with Z values 57, 58, and 59 respectively. In lanthanum, ten gamma rays of energies 175.0, 194.0, 200.5, 211.7, 226.2, 229.5, 250.3, 260.8, 278.3, and 285.2 keV were seen, although some of the weaker transitions may belong to the element barium (Z = 56). Fourteen gamma rays with energies of 145.2, 155.7, 161.7, 167.0, 184.9, 203.8, 214.8, 220.3, 223.3, 241.6, 245.7, 252.4, 256.9, 287.8 keV were found in cerium. In praseodymium four gamma ray transitions with energies 192.9, 201.7, 234.0, and 272.5 keV, although some of the gamma rays may belong to neodymium (Z = 60). This experiment was not designed to measure the mass of the fragment producing the gamma radiation and it could not experimentally be determined which isotope of the three elements studied was the source of the observed gamma transitions. However the observed gamma rays with the strongest relative intensities are probably from the fragment with the most probable mass for that element, given earlier by Watson, et al. On this basis the following tentative mass assignments were made. The 214.8-keV transition in cerium belongs to ^{147}Ce, and 211.7-keV gamma ray from lanthanum belongs to ^{146}La. (Diss. Abstr.)

24559 FISSION CROSS-SECTION RATIO MEASUREMENTS OF ^{239}Pu AND ^{233}U TO ^{235}U FROM 0.24 TO 24 keV. Lehto, Wayne K. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Sci. Eng.; 39: 361-7(Mar 1970).

The fission cross-section ratios of ^{239}Pu to ^{235}U and ^{233}U to ^{235}U were measured from 0.24 to 24 keV using parallel-plate, back-to-back fission detectors and a slowing down lead spectrometer as a neutron source. Relative fission rates obtained from the experiments were converted to true fission cross-section ratios by detector intercalibration in a thermal-neutron flux. In the case of the Pu/U ratio, these results extend the data to below several keV where measurements have not previously been made and the ^{233}U/^{235}U results verify previous measurements made in this energy region. (auth)

24560 THE LOW-LYING ENERGY LEVELS IN ^{92}Tc, ^{94}Tc, AND ^{96}Tc. de Jesus, A. S. M.; Rautenbach, W. L. (CSIR, Pretoria). Nucl. Phys.; A138: 626-30(1969).

The low-lying energy levels of ^{92}Tc, ^{94}Tc and ^{96}Tc were determined by using (p,nγ) threshold measurements with the reactions ^{92,94,96}Mo(p,nγ)^{92,94,96}Tc. Four new levels were found for ^{92}Tc, five new levels for ^{94}Tc and ten new levels for ^{96}Tc. (auth)

24561 DISINTEGRATION OF HEAVY NUCLEI BY ELECTRONS AND POSITRONS. Grishaev, I. A.; Efimov, V. P.; Kasilov, V. I.; Noga, V. I.; Ranyuk, Yu. N.; Sorokin, P. V.; Fisun, A. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh.; 14: 1817-19(Nov 1969). (In Russian).

Cross-section ratios for ^{238}U and ^{181}Ta disintegration by electrons and positrons are equal to unity within the experimental errors over the investigated energy range from 70 to 1000 MeV and are in agreement with Barber's measurements and Rodenberg's calculations. (auth)

24562 NEUTRON RESONANCES OF Dy RARE ISOTOPES. Vertebnyi, V. P.; Kal'chenko, A. I.; Pasechnik, M. V.; Pisanko, Zh. I.; Padun, G. S.; Rudyshin, V. K. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 14: 1810-16(Nov 1969). (In Russian).

The transmissions of the samples of ^{156,158,160}Dy isotopes and natural Dy were measured by the time-of-flight method with a fast chopper on the reactor within the energy range 3 to 1000 eV, neutron resolution being 0.05 μ sec/m, within the energy range 0.1 to 3 eV it was 0.2 μ sec/m. Neutron level widths and radiation widths of low-lying levels were determined. Average distances between the levels of D_{obs} and D_{obs}^{red} with the excitation energy U = 6 MeV are presented. Dependence of D_{red} on N has the maximum in the region of magic numbers. The strength function of ^{156}Dy amounts to 2.2×10^{-4} and slightly differs from the values of strength functions of other Dy isotopes as well as of Gd and Er isotopes. (auth)

24563 NOTE ON THE THIRD EXCITED LEVEL OF ^{200}Hg. Sakai, Mitsuo (Tokyo Univ.); Kawakami, Hirokane; Saito, Kazuo. J. Phys. Soc. Jap.; 28: 542-5(Mar 1970).

Internal conversion lines in the decay of ^{200}Tl were measured with a large air-core spectrometer. The spin assignment for the third excited 1029-keV level of ^{200}Hg is discussed mainly based on the multipolarity of the 661-keV transition from this level to the first 2^+ level. It was found to be of almost pure E2 character from the experimental L-subshell line ratios. The spin and parity of the level are concluded to be most likely 0^+. The internal conversion measurement of the 1029-keV line with high resolution showed the presence of a doublet of 1027.13-keV and 1029.21-keV lines. The monopole strength parameter of the 1029-keV E0 transition is estimated to be $0.53 \times 10^{-2} \geq \rho$. (auth)

24564 ROTATIONAL LEVELS IN ^{167}Tm AND ^{171}Lu. Noma, Hiroshi; Shibata, Tokushi; Yoshizawa, Yasukazu (Osaka Univ.). J. Phys. Soc. Jap.; 28: 546-55(Mar 1970).

Gamma-rays and internal conversion electrons from the ^{165}Ho(α,2n) ^{167}Tm and ^{169}Tm(α,2n) ^{171}Lu reactions were studied with a Ge(Li) detector and a beta-ray spectrometer. Excitation curves of these reactions were measured in the alpha-particle energies from 22 to 25 MeV. Rotational levels in the K = $1/2^+$ ground-state band of ^{167}Tm and the K = $7/2^+$ ground-state band of ^{171}Lu were assigned up to $23/2^+$ and $17/2^+$ levels, respectively. (auth)

24565 PHOTOEXCITATION OF THE 7.64-MeV MAGNETIC DIPOLE LEVELS IN ^{112}Cd AND ^{62}Ni BY IRON CAPTURE GAMMA RAYS. Estes, G. P. (Univ. of Virginia, Charlottesville); Min, K. Phys. Rev., C; 1: 201-6(Jan 1970).

The elastic and inelastic scattering of iron capture γ rays from the 7.64-MeV M1 levels in ^{112}Cd and ^{62}Ni were studied with a Ge (Li) spectrometer. Eleven energy levels in ^{112}Cd and three in ^{62}Ni observed in this experiment are compared with the levels excited in (d, p) experiments. Angular distribution measurements were made for four strong transitions in ^{112}Cd and two in ^{62}Ni, giving the following spin assignments: ^{112}Cd: 0.62-MeV level (2), 1.23-MeV (0), 1.88-MeV (0), 7.64-MeV (1); ^{62}Ni: 2.06-MeV (0), 7.64-MeV (1). In both nuclei, only the 0^+ member of the two-quadrupole phonon triplet (0^+, 2^+, 4^+) is strongly excited in this experiment, indicating very different components in the wave functions of the 0^+ and 2^+ members. (auth)

24566 FRAGMENT ENERGY AND VELOCITY MEASUREMENTS IN FISSION OF BISMUTH BY 2.9-GeV PROTONS. Remsberg, L. P.; Plasil, F.; Cumming, J. B.; Perlman, M. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 265-70 (Jan 1970).

With semiconductor detectors and time-of-flight equipment, measurements, similar to those made in a previous study of uranium fission, were made on members of fragment pairs resulting from fission of bismuth induced by 2.9-GeV protons. Fragment-pair angular correlation and fragment energies were measured in addition to velocity of one fragment; single-fragment mass spectra were thus determined. It was inferred from the mean fragment masses that the distribution of cascade deposition energies associated with bismuth fission is narrower than it is for uranium fission; neither low deposition energies nor very high deposition energies contribute appreciably to bismuth fission, although they are both important in uranium fission. The mean fragment velocity is found to be identical with that for uranium fission. It is concluded that the mechanism of high-energy bismuth fission is essentially indistinguishable from that operative in fission at low excitation energies generally. (auth)

24567 DECAYS OF ^{170}Tm AND ^{171}Tm: L_2 AND L_3 SUBSHELL-FLUORESCENCE YIELDS, COSTER-KRONIG TRANSITION PROBABILITIES, AND K-SHELL CONVERSION COEFFICIENTS IN Yb. Mohan, S. (Georgia Inst. of Tech., Atlanta); Freund, H. U.; Fink, R. W.; Rao, P. Venugopala. Phys. Rev., C; 1: 254-9(Jan 1970).

High-resolution Ge(Li) and Si(Li) x-ray detectors [404- and 290-eV full width at half-maximum (FWHM) at 6.4 keV, respectively] were employed to study the singles and coincidence spectra of x rays and γ rays from the decays of ^{170}Tm and ^{171}Tm. Measurements of the rates of L_{α}, L_{β}, and L_{γ} x-ray emission in coincidence with K_{α_1} and K_{α_2} x rays yielded the following values for L_2 and L_3 subshell-fluorescence yields (ω_2, ω_3), L_2-L_3X Coster-Kronig transition probability (f_{23}), and relative L x-ray intensity ratios (s_2, s_3): $\omega_2 = 0.182 \pm 0.011$, $\omega_3 = 0.183 \pm 0.011$, $f_{23} = 0.170 \pm 0.009$, $s_2 = 0.192 \pm 0.010$, and $s_3 = 0.165 \pm 0.009$. The K-conversion coefficient of the 84.2-keV E2 transition in ^{170}Yb is found to be 1.39 ± 0.04 by the measurement of the intensity ratio for the K-x-ray and γ transitions (XPG method). The K-conversion coefficient of the 66.7-keV transition in ^{171}Yb is found to be 7.45 ± 0.36, which leads

to a value of 0.34 for the mixing ratio of E2/M1. The orbital-electron-capture branchings of ^{170}Tm to the first excited state (78.6 keV) and to the ground state in ^{170}Er are determined to be 0.04 and 0.10%, respectively. (auth)

24568 FISSIONABILITY AS A FUNCTION OF ANGULAR MOMENTUM FOR THE ^{181}Re COMPOUND NUCLEUS AT AN EXCITATION ENERGY OF 70 MeV. Kowalski, L.; Zebelman, A. M.; Miller, J. M.; Herzog, G. F.; Reedy, R. C. (Columbia Univ., New York). Phys. Rev., C; 1: 259-64(Jan 1970).

A method is described which allows the calculation of the spin dependence of the probability for fission of compound nuclei from experimental data. The method is applied to the study of the behavior of ^{181}Re compound nuclei formed in three different ways with an excitation energy of 70 MeV: ^{12}C + ^{169}Tm, ^{16}O + ^{165}Ho, and ^{22}Ne + ^{159}Tb. The experimental fission cross sections were taken from Sikkeland. The fission probability is found to increase with increasing angular momentum in accord with liquid-drop-model calculations. (auth)

24569 REACTION ^{116}Sn(α,^{3}He) AT 65.7 MeV. Bingham, C. R. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Halbert, M. L. Phys. Rev., C; 1: 244-8(Jan 1970).

Differential cross sections for ^{116}Sn(α, ^{3}He) with 65.7-MeV α particles were measured from 15° to 80°. Data were obtained for ^{3}He groups corresponding to excitation energies of 0.0, 0.16, 0.32, 0.72, 1.03, 1.25, 1.58, and 3.20 MeV in ^{117}Sn. The angular distributions were well fitted by zero-range distorted-wave predictions. The spectroscopic factors are generally in good agreement with those obtained in a (d,p) experiment. (auth)

24570 DETERMINATION OF PARTICLE PARAMETERS IN THE K, L, AND M SHELLS IN ^{201}Pb. Bosch, H. E. (Instituto de Investigaciones Aeronauticas y Espaciales, Buenos Aires); Gatto, L. F.; Behar, M.; Garcia, G. J. Phys. Rev., C; 1: 242-4(Jan 1970).

An angular-correlation setup was applied to measure the e-γ angular correlations involving the 570- and 1064-keV transitions in ^{207}Pb. The use of a Si(Li) semiconductor counter as an electron detector allowed the separation of the three K, L, and M conversion lines for both transitions γ-γ angular correlations were also performed. Particle parameters b_2 were thus experimentally determined. The values obtained for the K, L, and M shells were 1.19(7), 1.13(7), and 1.41(11) for the 570-keV transition and 1.05(5), 1.06(12), and 1.16(15) for the 1064-keV transition. Particle parameters b_4 were calculated from the b_2 values through a recursion relation. The coefficients A_4(e) could not be determined directly from experiment owing to the lack of statistics, but they were obtained through the b_4 particle parameters and the $A_4(\gamma)$ coefficients. The values for the K, L, and M shells one –0.020(8), –0.025(9), and ~ –0 are for the e(570)-γ(1064) angular correlations; and –0.049(16), –0.051 (30), and –0.072(40) for the e(1064)-γ(570) angular correlations. (auth)

24571 ^{208}Pb(t, α)^{207}Tl AND ^{207}Pb(t, α)^{206}Tl REACTIONS AT 20 MeV. Barnes, P. D.; Flynn, E. R.; Igo, G. J.; Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 1: 228-41 (Jan 1970).

The proton pickup reaction (t, α) was used to investigate states in ^{207}Tl and ^{206}Tl. The angular distributions resulting from populating five states in ^{207}Tl which are predominantly single-hole in character were analyzed to obtain spectroscopic factors. In the ^{207}Pb(t, α)^{206}Tl spectrum, doublets corresponding to the interaction of proton holes in the four lowest-lying orbits with a $3p_{\frac{1}{2}}$ neutron hole are the strongest states observed. The $2d_{\frac{1}{2}}$ proton-hole strength is found in several levels of ^{206}Tl. The position and intensities of the observed levels are in quantitative agreement with the nuclear-structure calculations of Kuo. (auth)

24572 γ–γ DIRECTIONAL CORRELATIONS IN ^{133}Cs VIA Ge(Li)–Ge(Li) MEASUREMENTS. Winn, W. G.; Sarantites, D. G. (Washington Univ., St. Louis). Contracts AT-(11-1)-1530; AT-(11-1)-1760. Phys. Rev., C; 1: 215-28(Jan 1970).

The multipole mixing ratios for the 53.17-, 79.63-, 80.99-, 160.63-, and 302.83-keV transitions in ^{133}Cs were measured via γ–γ directional correlation measurements employing two Ge(Li) detectors. Correlations for the cascades 276-161, 356-81, 303-81, 80-81, (276-80) + (276-81), 53-384, and 53-303 keV were investigated. Results for the last three correlations have not been reported previously. The present results are consistent with a J^π sequence of $\frac{7}{2}^+$, $\frac{5}{2}^+$, $\frac{3}{2}^+$, $\frac{3}{2}^+$, and $\frac{1}{2}^+$ for the ground state and the 81-, 161-, 384-, and 437-keV levels in ^{133}Cs. With the 276-, 356-, and 384-keV transitions assumed to be pure E2, the mixing ratios δ for E2/M1 obtained are 161 keV: –1.03; 81 keV: +0.148; 303 keV: –0.164; 80 keV; +0.022 ± 0.040 (average from two independent correlations); and 53 keV: –0.114 (average from two independent correlations). These results are compared with previously reported mixing ratios γ–γ and e_K–γ correlations and from α_K, K/L, and L-subshell ratio measurements. From these results and previously reported lifetimes, γ-ray-transition retardation and enhancement factors are calculated and compared with predictions of current models for the nucleus. (auth)

24573 THE MOESSBAUER EFFECT FOLLOWING COULOMB EXCITATION OF ^{183}W, ^{178}Hf, AND ^{180}Hf. Hardy, Kenneth Albert. New Orleans; Tulane Univ. (1969). 61p.

Thesis.

The Moessbauer effect following Coulomb excitation has been proven to be a valuable tool for the investigation of properties of nuclear levels not readily accessible through radioactive decay. In a systematic study of nuclear moments the technique allows the use of the same type source-absorber combination for all isotopes, permitting the ratio of moments to be observed directly. An experimental apparatus is described which can be used for Moessbauer effect studies using the Coulomb excitation technique or using radioactive sources. The use of a closed cycle helium refrigerator to cool the target (source) and absorber to 12K is discussed. Computer programs are described which compute theoretical Moessbauer absorption spectra, perform gamma ray pulse height spectra stripping, and which use the method of least squares to analyze Moessbauer absorption spectra. The Moessbauer effect was observed in the 46.5-keV state of ^{183}W following Coulomb excitation with 3.3-MeV protons. The spectrum exhibits a single absorption line with an absorption of 8.1 ± .5% and a half width of 4.72 ± .24 cm/sec, which corresponds to a $T_{\frac{1}{2}}$ = .194 ± .010 η sec. The quadrupole moment ratio of ^{178}Hf/^{180}Hf was measured using the Coulomb excitation Moessbauer effect. The targets were isotopically enriched HfO_2 and the absorber was HfC. Three line absorption spectra were observed in each isotope, and the ratio of the quadrupole moments was found to be 1.01 ± .07. These results are compared with the results of other investigations. (Diss. Abstr. Int., B)

24574 ACTIVATION CROSS SECTIONS FOR (n,p), [(n,np) + (n,pn) + (n,d)], AND (n,α) REACTIONS IN THE REGION OF Z = 40 TO 58 AT 14.4 MeV. Lu, Wen-deh; RanaKumar, N.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 1: 358-61(Jan 1970).

The following activation cross sections (in mb) for the (n,p), [(n,np) + (n,pn) + (n,d)], and (n,α) reactions in the region of Z = 40–58 were determined at 14.4 ± 0.3 MeV by using the mixed powder method with Ge(Li) γ-ray detection: ^{90}Zr(n,p)^{90m}Y (3.1 h), 12.9 ± 1.0; ^{91}Zr(n,p)^{91m}Y (50.3 min), 18.6 ± 1.9; ^{92}Zr(n,p)^{92}Y (3.53 h), 18.5 ± 2.7; ^{92}Mo(n,p)^{92m}Nb (10.1 day), 62.5 ± 4.0; ^{93}Mo(n,p)^{93}Nb (23.35 h), 21.3 ± 1.5; ^{97}Mo(n,p)^{97m}Nb (1 min), 7.4 ± 0.8; ^{97}Mo(n,p)^{97g}Nb (72 min), 8.5 ± 1.0; ^{98}Mo(n,p)^{98g}Nb (51 min), 4.1 ± 0.5; ^{98}Ru(n,p)^{98}Tc (4.35 day), 146 ± 7; ^{103}Rh(n,p)^{103}Ru (39.5 day), 16.9 ± 1.5; ^{105}Pd(n,p)^{105}Rh (35.9 h), 37.6 ± 2.0; ^{106}Pd(n,p)^{106m}Rh (130 min), 6.0 ± 0.4; ^{106}Pd(n,p)^{106g}Rh (30 sec), 18 ± 4; ^{108}Pd(n,p)^{108}Rh (16.8 sec), 8.3 ± 1.5; ^{112}Cd(n,p)^{112}Ag (3.14 h), 15.0 ± 1.3; ^{116}Sn(n,p)^{116m}In (54 min), 7.9 ± 0.8; ^{117}Sn(n,p)^{117m} In (1.93 h), 5.7 ± 1.5; ^{117}Sn(n,p)^{117g}In (45 min), 9.8 ± 1.6; ^{138}Ba(n,p)^{138}Cs (32.2 min), 3.8 ± 0.6; ^{140}Ce(n,p)^{140}La (40.22 h), 6.3 ± 0.5; ^{94}Zr(n,α)^{91}Sr (9.67 h), 5.0 ± 1.0; ^{93}Nb(n,α)^{90m}Y (3.1 h), 5.3 ± 0.5; ^{92}Mo(n,α)^{89m}Zr (4.18 min), 9.4 ± 0.9; ^{92}Mo(n,α)^{89g}Zr (78.4 h), 18.7 ± 1.5; ^{98}Mo (n,α)^{95}Zr (65.5 day), 8.1 ± 1.0; ^{106}Pd(n,α)^{103}Ru (39.5 day), 5.6 ± 0.7; ^{108}Pd(n,α)^{105}Ru (4.44 h), 2.7 ± 0.3; ^{133}Cs(n,α)^{130}I (12.3 h), 1.96 ± 0.15; ^{138}Ba(n,α)^{135m}Xe (15.6 min), 0.55 ± 0.05; ^{138}Ba(n,α)^{135g}Xe (9.14 h), 2.0 ± 0.2; ^{142}Ce(n,α)^{139}Ba (82.9 min), 6.0 ± 1.0; ^{96}Ru[(n,np) + (n,pn) + {n,d)] ^{95m}Tc(61.0 day), 52 ± 10; and ^{96}Ru[(n,np) + (n,pn) + (n,d)]^{95g}Tc (20 h), 483 ± 50. The total (n,p) cross sections are compared with Levkovskii's predictions and show good agreement. The relative (n,p) cross sections of Mo and Pd also are comared with Gardner's predictions. (auth)

24575 ACTIVATION CROSS SECTIONS FOR (n,2n) REACTIONS AT 14.4 MeV IN THE REGION Z = 40 to 60: PRECISION MEASUREMENTS AND SYSTEMATICS. Lu, Wen-deh; Rana-Kumar, N.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 1: 350-7(Jan 1970).

Activation cross sections for the (n,2n) reaction in the region of Z = 40–60 at 14.4 ± 0.3 MeV were measured by using the mixed-powder method and Ge(Li) γ-ray detection. The total cross sections (m + g) measured are (in mb) ^{90}Zr, 652 ± 31; ^{96}Zr, 1456 ± 80; ^{92}Mo, 217 ± 18; ^{100}Mo, 1389 ± 84; ^{96}Ru, 569 ± 30; ^{98}Ru, 1168 ± 96; ^{104}Ru, 1440 ± 80; ^{103}Rh, 957 ± 57; ^{102}Pd, 637 ± 45; ^{110}Pd, 1416 ± 150; ^{106}Cd, 865 ± 100; ^{110}Cd, 1221 ± 150; ^{116}Cd, 1389 ± 71; ^{114}Sn, 1239 ± 130; ^{121}Sb, 1615 ± 63; ^{123}Sb, 1542 ± 80; ^{122}Te, 1615 ± 110; ^{128}Te, 1661 ± 161; ^{130}Te, 1455 ± 55; ^{127}I, 1649 ± 80; ^{133}Cs, 1542 ± 75; ^{132}Ba, 1574 ± 100; ^{136}Ce, 1318 ± 90; ^{140}Ce, 1593 ± 130; and ^{141}Ce, 1730 ± 170. Some partial (n,2n) cross sections also are reported. The measured values are compared with the semiempirical predictions of Pearlstein and of Gardner. No significant shell effects are seen, and the data suggest that 14-MeV (n,2n) reactions are governed predominantly by the statistical model of the compound nu-

cleus. An empirical fit for the ratio of neutron emission to all modes of compound-nucleus decay, $\sigma_{n,M}/\sigma_{ne}$, is deduced from the present results. (auth)

24576 NUCLEAR-STRUCTURE STUDY OF ^{98}Mo FROM (p,p') ON ANALOG RESONANCES. Kent, James J.; Moore, C. Fred; Watson, Charles E. (Univ. of Texas, Austin). Phys. Rev., C; 1: 346-9(Jan 1970).

Elastic and inelastic proton scattering on ^{96}Mo was performed over the region of excitation of isobaric analog resonances to investigate the nature of the first two excited states of ^{98}Mo at 0.736 MeV (0^+) and 0.787 MeV (2^+). The experiment allowed the determination of spectroscopic factors for states in ^{99}Mo relative to these two excited core states in ^{98}Mo. Spectroscopic factors extracted from the elastic data are appreciably smaller than the corresponding (d,p) spectroscopic factors. Angular distributions taken on the inelastic scattering resonances are used to determine the j value in the exit channel. The 0.736-MeV (0^+) and 0.787-MeV (2^+) states of ^{96}Mo are not found to be "good" core states for weak coupling. (auth)

24577 ISOBARIC ANALOG RESONANCES IN ^{92}Zr(p,p'). Kent, James J.; Lieb, K. P.; Moore, C. Fred (Univ. of Texas, Austin). Phys. Rev., C; 1: 336-45(Jan 1970).

Excitation functions were measured for elastic and inelastic scattering of protons on a ^{92}Zr target in the bombarding energy range of 6.0 to 10.0 MeV. Inelastic groups were detected from the 2^+ (0.93-MeV), 0^+ (1.38-MeV), 2^+ (1.85-MeV), 2^+ (2.07-MeV), and 3^- (2.33-MeV) levels of ^{92}Zr. Angular distributions taken on inelastic scattering resonances were used to identify the total angular momenta of the inelastically scattered protons. Partial widths were extracted for elastic and inelastic scattering resonances and spectroscopic factors calculated. From these, weak-coupling wave functions for several levels in ^{93}Zr were obtained for neutrons coupled to the various excited states of ^{92}Zr. (auth)

24578 K-CAPTURE BRANCH IN THE DECAY OF ^{113m}In. Ramaswamy, M. K. (Brookhaven National Lab., Upton, N. Y. Fordham Univ., Bronx, N. Y.). Phys. Rev., C; 1: 333-6(Jan 1970).

^{113m}In is known to decay with a 99-min half-life predominantly by an M4 transition of 393 keV to ^{113}In. It was found that it also decays by a weak K-capture branch of (0.07 _ 0.01)% to ^{113}Cd. Using a high-resolution Ge(Li) detector (600 eV for the ^{55}Fe K x ray) and ^{113m}In sources, careful experiments were carried out which reveal the presence of Cd K x rays with an intensity of 0.0024 relative to In K x rays. Supporting evidence comes from the (CdKα)/(CdKβ) ratio of 4 ± 2, the half-life, and the observation that chemical treatment to remove Cd impurity that might be fluorescence-excited by the In Kβ x rays did not affect the Cd K x-ray intensity. The measured intensity corresponds to a log ft of 5.1 ± 0.3. This is rather low but not unusual for a first-forbidden transition. Analysis of the effects of backscattering and collimation was crucial to the success of the experiment. The significance of the result lies in the fact that the inverse reaction $^{113}Cd + \nu \rightarrow {}^{113m}In + e^- \rightarrow {}^{113}In + 393\ keV + e^-$ could serve as a possible low-threshold detector for low-energy neutrinos (<100 keV). (auth)

24579 LEVELS OF ^{237}Np EXCITED BY THE ^{236}U(^{3}He,d)^{237}Np and ^{236}U(α,t)^{237}Np REACTIONS. Elze, Th. W.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Phys. Rev., C; 1: 328-32(Jan 1970).

The ^{236}U(^{3}He,d)^{237}Np and ^{236}U(α,t)^{237}Np reactions were studied with 30-MeV ^{3}He and ^{4}He beams. Rotational bands built upon the following Nilsson proton configurations in ^{237}Np were identified: $5/2^+$[642] (0 keV), $1/2^-$[523] (60 keV), $1/2^-$[530] (268 keV), $3/2^-$[521] (514 keV). Experimental spectroscopic factors are compared with theoretical ones computed for Woods-Saxon and harmonic-oscillator-type nuclear potentials. A strong l dependence of the cross-section ratio $d\sigma(\alpha,t)/d\sigma(^3He,d)$ was observed. (auth)

24580 NEUTRON AND PHOTON EMISSION FROM Ba COMPOUND NUCLEI. Subrahmanyam, V.; Kaplan, Morton (Yale Univ., New Haven). Phys. Rev., C; 1: 322-7(Jan 1970).

Recoil angular distribution measurements from (^{12}C,xn) compound-nucleus reactions with ^{116}Sn, ^{119}Sn, ^{120}Sn and ^{122}Sn are reported. In each case, the final product investigated was ^{126}Ba, corresponding to reactions in which 4, 5, 6, and 8 neutrons are emitted. The data were analyzed to yield information on the average total energies of neutrons and photons emitted in the deexcitation of the compound nuclei. Evidence is presented for significant competition between neutron evaporation and γ-ray deexcitation processes, particularly for the 4n and 5n reactions. At the higher bombarding energies, the total energy dissipated as γ radiation is an appreciable fraction of the available decay energy. (auth)

24581 NUCLEAR CHARGE DISTRIBUTION IN FISSION: INDEPENDENT YIELDS OF ^{132}I, ^{133}I, AND ^{134}I FROM THERMAL NEUTRON FISSION OF ^{233}U. Runnalls, N. G. (Stout State Univ., Menomonie, Wis. Oak Ridge National Lab., Tenn.); Troutner, D. E. Phys. Rev., C; 1: 316-22(Jan 1970).

Independent yields of ^{132}I, ^{133}I, and ^{134}I were measured from thermal-neutron-induced fission of ^{233}U. The yields, each expressed as the ratio of iodine independent yield to iodine cumulative yield, are 0.06 ± 0.03, 0.21 ± 0.03, and 0.370 ± 0.013 for ^{132}I, ^{133}I, and ^{134}I, respectively. Values of Z_p estimated from these yields with the assumption that charge distribution can be represented by a Gaussian curve with standard deviation σ of 0.59 ± 0.06 are $51.58^{+0.21}_{-0.30}$, $52.02^{+0.10}_{-0.12}$, and 52.33 ± 0.03 for ^{132}I, ^{133}I, and ^{134}I, respectively. The values of Z_p are consistent with those previously reported for other chains in this mass region. (auth)

24582 INDEPENDENT YIELDS OF ^{95}Zr FROM THERMAL-NEUTRON FISSION OF ^{235}U AND ^{233}U. Niece, L. H. (Univ. of Missouri, Columbia); Troutner, D. E.; Ferguson, Robert L. Phys. Rev., C; 1: 312-15(Jan 1970).

Independent fission yields of ^{95}Zr from thermal neutron fission of ^{235}U and ^{233}U were determined to be 0.004 ± 0.002 and 0.034 ± 0.006, respectively. From the values obtained, together with previously measured yields, the width of the charge dispersion for mass-95 fission products in ^{235}U fission was found to be 0.53 ± 0.03 in terms of the width parameter σ of the normal Gaussian curve. An upper limit of 0.56 for σ in the case of mass-95 products from ^{233}U fission indicates that charge dispersion in this system is similar to that for ^{235}U. (auth)

24583 LIFETIMES AND NUCLEAR MOMENTS IN ^{192}Os AND ^{192}Pt. Beraud, R.; Berkes, I.; Chery, R.; Haroutunian, R.; Levy, Michele; Marguier, G.; Marest, G.; Rougny, R. (Univ., Lyon). Phys. Rev., C; 1: 303-11(Jan 1970).

Lifetimes, nuclear g factors, and E2/M1 mixing ratios were determined in ^{192}Os and ^{192}Pt, and some previous determinations reevaluated. The following values were established. For ^{192}Os: g_2 = +0.29 ± 0.05; δ(484) = +7.6. For ^{192}Pt: τ_2 = 50.0 ± 3.4 psec; τ_2' = 29 ± 3 psec; g_2 = +0.296 ± 0.022; g_2' = +0.29 ± 0.05; δ(604) = +2.5 ± 0.2; δ(308) = −6.3. Nuclear magnetic moments are analyzed in terms of Greiner's vibrational-rotational model, transition probabilities and E2/M1 mixing ratios are compared to the theoretical predictions of Kumar and Baranger's model. (auth)

24584 ISOMERIC STATES OF Po ISOTOPES IN THE NANOSECOND RANGE POPULATED BY Pb(α,xn) REACTIONS. Yamazaki, T. (Univ. of California, Berkeley. Tokyo Univ.). Phys. Rev., C; 1: 290-303(Jan 1970).

Isomeric states of Po isotopes from A = 204 to A = 211 were investigated by means of the nanosecond time analysis of Pb(α,xn) γ rays produced in natural beam bunches of a cyclotron. In addition to those already reported, new isomeric states were revealed systematically. The following half-lives were measured: ^{204}Po: 190 ± 20 nsec; ^{206}Po: 160 ± 40 nsec; ^{208}Po: 380 ± 100 nsec; and ^{210}Po: 110 ± 10 nsec. The possibility that such half-lives are associated with the expected 8+ state of predominant configuration $h_{9/2}^2$(p) is discussed. Another half-life (24 nsec) found in ^{210}Po was assigned as a ($h_{9/2}i_{13/2}$) 11-isomeric state. Odd isotopes show three-particle isomeric states in addition to the $i_{13/2}$(n) isomeric state. Several characteristic features revealed in this study are discussed. (auth)

24585 (d,p) AND (d,t) REACTION STUDIES OF THE ACTINIDE ELEMENTS. I. ^{235}U. Braid, T. H.; Chasman, R. R.; Erskine, J. R.; Friedman, A. M. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 275-89(Jan 1970).

Levels of the nucleus ^{235}U, populated in the reactions ^{234}U(d,p)^{235}U and ^{236}U(d,t)^{235}U induced by 12-MeV deuterons, were analyzed with a magnetic spectrograph. Most of the observed levels were identified as members of rotational bands built on the single-particle states of a deformed central field. The level assignments were made on the basis of relative populations of presumed members of each rotational band, ratios of the cross sections at 90 and 140°, and (d,p)/(d,t) cross-section ratios. Pairing effects were calculated for the observed spectrum, and a single-particle scheme was extracted from the data. This single-particle scheme was compared with the calculations of Nilsson and Rost. Levels not predicted on the basis of the single-particle models were observed at excitations as low as 700 keV. Some of these levels, presumably vibrational excitations, were found to have cross sections comparable to those of single-particle states. (auth)

24586 MULTIPOLARITY OF TRANSITIONS IN ^{171}Lu. Gizon, Jean; Barneoud, Daniel; Boutet, Jean; Valentin, Jacques (Institut des Sciences Nucleaires, Grenoble, France). Compt. Rend., Ser. B; 269: 543-5(22 Sep 1969). (In French).

A determination is made of the multipolarity of transitions in the decay ^{171}Hf → ^{171}Lu. (tr-auth)

24587 ENERGY DISTRIBUTIONS IN PROMPT-FISSION FRAGMENTS. Sarkar, Ratna; Chatterjee, Aparesh (Calcutta Univ. Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., C; 1: 619-23(Feb 1970).

Excitation and kinetic energies of prompt-fission fragments are predicted by considering a renormalized Fermi-gas model (RGM) and the concept of the potential-energy surface (PES). The RGM treats the residual nuclear interactions as energy corrections on the free-gas Fermi surface. The ground-state RGM corrections of the fragments over those of the fissioning nucleus give directly a part of the fragment excitation energy and reproduce the shape of the prompt-neutron yield curve. The remaining part of the excitation is obtained from the change of the deformation-dependent part of the PES evaluated at the scission point. The total energy released in fission is also found from the PES. The kinetic energy is estimated from the conservation of energy. All predicted energies agree well with experiments in the thermal-neutron-induced fission of ^{235}U and ^{239}Pu. (auth)

24588 GAMMA RAYS IN COINCIDENCE WITH K X RAYS FROM THE La, Ce, AND Pr FISSION FRAGMENTS OF ^{252}Cf. Ruegsegger, D. R. Jr.; Roy, R. R. (Arizona State Univ., Tempe). Phys. Rev., C; 1: 631-4(Feb 1970).

An experiment was carried out to study the γ rays from the fission fragments of ^{252}Cf. The Z values of the fragments studied were determined by detecting their Kα_1 x rays with a Si(Li) x-ray spectrometer. A single-channel analyzer was used to accept only pulses corresponding to the Kα_1 x rays of the element under study. The γ rays were detected with a Ge(Li) detector, and a time coincidence system was used to accept only the γ-ray pulses that occurred within 0.175 μsec of the preselected x ray. Energy transitions in three fission elements, La(Z = 57), Ce(Z = 58), and Pr(Z = 59), were observed in an energy range 125–300 keV. Eleven γ transitions were seen in La, fourteen in Ce, and four in Pr, although some of the weaker γ rays attributed to La and Pr may belong to Ba(Z = 56) and Nd(Z = 60), respectively. (auth)

24589 INTERNAL-CONVERSION PENETRATION EFFECTS IN M1 TRANSITIONS OF ^{133}Cs. Avignone III, F. T. (Univ. of South Carolina, Columbia); Frey, G. D.; Hendrick, L. D. Phys. Rev., C; 1: 635-43(Feb 1970).

Internal-conversion-coefficient and directional correlation measurements were used to determine the penetration parameter λ for the 81-, 161-, and 303-keV transitions of ^{133}Cs. The following internal-conversion coefficients were measured: $\alpha_K(356) = 0.020 \pm 0.001$, $\alpha_K(303) = 0.039 \pm 0.002$, $\alpha_K(161) = 0.21 \pm 0.02$, $\alpha_K(81) = 1.46 \pm 0.05$, and $\alpha_{L+M+N}(81) = 0.314 \pm 0.020$. Existing L-, M-, and N-shell relative intensities of the 81-keV transition were used with $\alpha_{L+M+N}(81)$ to deduce the following subshell coefficients: $\alpha_{L_I}(81) = 0.196 \pm 0.020$, $\alpha_{L_{II}}(81) = 0.029 \pm 0.004$, $\alpha_{L_{III}}(81) = 0.022 \pm 0.004$, and $\alpha_M(81) = 0.044 \pm 0.009$. The K/(L + M) conversion ratios of the 276- and 161-keV transitions were measured as 4.75 ± 0.15 and 3.75 ± 0.25, respectively. The following directional correlation functions were measured: $W(356\gamma - 81\gamma) = 1 + (0.0355 \pm 0.0037) P_2(\cos\theta) + (0.000 \pm 0.008) P_4(\cos\theta)$, $W(276\gamma - 161\gamma) = 1 - (0.420 \pm 0.009) P_2(\cos\theta) - (0.028 \pm 0.010) P_4(\cos\theta)$, $W(276\gamma - 161e_K^-) = 1 - (0.256 \pm 0.020) P_2(\cos\theta) - (0.090 \pm 0.025) P_4(\cos\theta)$. The following directional correlation coefficients were also measured: $A_2(276e_K^- - 161\gamma) = -0.7 \pm 0.1$ and $A_2(303e_K^- - 81\gamma) = 0.003 \pm 0.008$. Using the above body of data, the following penetration parameters were determined: $\lambda(81) = 2.8 \pm 2.3$, $\lambda(161) = 41 \pm 6$, and $\lambda(303) = -2.0$. The retardation factors for the M1 components of the 81- and 161-keV transitions were reevaluated as ~420 and ~230, respectively. (auth)

24590 BETA–GAMMA ANGULAR CORRELATIONS AND SHAPE-FACTOR MEASUREMENTS IN ^{186}Re AND ^{188}Re. Trudel, M.; Habib, E. E.; Ogata, H. (Univ. of Windsor, Ont.). Phys. Rev., C; 1: 643-8(Feb 1970).

The A_2 coefficients in the directional correlation between the nonunique first forbidden 0.935-MeV β group and the 0.137-MeV γ ray in the decay of ^{186}Re, and in the directional correlation between the nonunique first forbidden 1.980-MeV β group and the 0.155-MeV γ ray in the decay of ^{188}Re, were measured as a function of energy. An investigation of perturbation caused by a magnetic hfs-type interaction yielded a negative result. Both of these β spectra were found to have the "allowed" shape over the region examined. (auth)

24591 HIGH-RESOLUTION ELECTRON AND GAMMA-RAY STUDIES AND CONVERSION-COEFFICIENT MEASUREMENTS IN ^{132}Xe. Carter, H. K. (Vanderbilt Univ., Nashville); Hamilton, J. H.; Manthuruthil, J. C.; Amtey, S. R.; Pinajian, J. J.; Zganjar, E. F. Phys. Rev., C; 1: 649-65(Feb 1970).

The γ-ray spectrum from the decay of ^{132}I was measured with small- and large-volume, high-resolution Ge(Li) detectors, and 116 transitions were assigned in its decay. Selected regions of the conversion-electron spectrum were measured with an iron double-focusing spectrometer. The K-conversion coefficient of the 772-keV transition that was measured relative to the K-conversion coefficient of the 662-keV transition in ^{137}Ba was used to normalize the electron and γ spectra to obtain the K-conversion coefficients of the 262.7-, 284.7-, 505.9-, 522.6-, 621.0-, 630.2-, 650.6-, 669.8-, 671.5-, 727.1-, 809.8-, 812.3-, 954.6-, 1136.0-, 1143.4-, 1173.2-, 1372.1-, and 1398.6-keV transitions. Conversion coefficients of additional transitions were obtained from electron intensities of other work. From these conversion coefficients, each of the above transitions was assigned an M1 and/or E2 multipolarity. (auth)

24592 GAMMA-GAMMA COINCIDENCE MEASUREMENTS AND THE LEVEL STRUCTURE OF ^{132}Xe. Hamilton, J. H. (Vanderbilt Univ., Nashville); Carter, H. K.; Pinajian, J. J. Phys. Rev., C; 1: 666-83(Feb 1970).

Two-parameter, 4096 × 4096, γ–γ coincidence measurements were carried out to establish the energy levels and placement of new γ rays observed in the decay of ^{132}I to ^{132}Xe. A NaI-Ge(Li) detector arrangement with a ND 3300 system was used. Spectra from the Ge(Li) detector in coincidence with 60-keV-wide NaI gates centered at 515, 630, 667, 772, 800, 954, 1110, and 1170 keV and 120-keV-wide gates centered at 1270 and 1410 keV were analyzed. These data were used to place 63 transitions into a scheme with the following energies (in keV), spins, and parities: 667.67, 2+; 1297.84, 2+; 1440.27, 4+; 1803.66, 3+; 1962.92, (3,4)+; 1985.3, 2(+); 2110.18, (3,4)+; 2111.8, (5,6)+; 2350.67, (3–5); 2394.93, (3,4)+; 2424.89, (3,4)+; 2583.75, (3–5)+; 2588.66, (3,4); 2613.50, (3–5)+; 2669.95, (3,4)+; 2754.43, (3,4); 2838.70, (3–5)+; 2840.29, (3,4)+; 2890.74, (3,4); and 3058.17, (3,4). Each level is based on observed coincidence relations. A tentative level assignment was also made for a 2041-keV (5–) level. An additional 10 levels are required by unplaced high-energy transitions. (auth)

24593 NEUTRON YIELD OF ^{252}Cf BASED ON ABSOLUTE MEASUREMENTS OF THE NEUTRON RATE AND FISSION RATE. De Volpi, A.; Porges, K. G. (Argonne National Lab., Ill.). Phys. Rev., C; 1: 683-94(Feb 1970).

The need for accurate measurements of the total yield of neutrons (ν) in spontaneous fission of ^{252}Cf has continued. Such a measurement, incorporating advances over previous work, was accomplished with a high degree of authentication. The yield was determined by separate direct evaluations of the neutron rate and fission rate of three fission-fragment counters plated with ^{252}Cf. The neutron emission-rate factor in the yield was found with the aid of a manganese-bath facility independently calibrated with reference to absolute β–γ coincidence counting of ^{56}Mn. Special measurements were also made of other subsidiary parameters, while precise support in the accuracy of neutron assay was obtained from comparisons with international standard sources. The fission rate was derived primarily from absolute fission-neutron coincidence data obtained from the fission counters, with special attention to angular-correlation effects. The resulting value of $\nu(^{252}\text{Cf}) = 3.725 \pm 0.015$ (total yield) is generally independent of cross sections, neutron spectrum assumptions, counting statistics, and fission-fragment self-absorption. The error assigned is a combination of statistical and systematic effects at a confidence level of 68%. Two unverified correction factors were isolated. (auth)

24594 ANGULAR MOMENTUM EFFECTS IN CHARGED-PARTICLE REACTIONS PRODUCING THE ISOMER PAIR ^{119m}Te–^{119g}Te. Seegmiller, David W.; Street, K. Jr. (Univ. of California, Berkeley). Phys. Rev., C; 1: 695-700(Feb 1970).

The effect of angular momentum on compound-nucleus reactions was investigated by measuring the formation cross-section ratios of the isomers of ^{119}Te. Nine reactions were studied. Five proceeded via the compound nucleus ^{122*}Te, and two each via the compound nuclei ^{121*}Te and ^{123*}Te. Projectiles ranging in size from ^{3}He to ^{18}O were employed. The experimentally determined ratios (upper-state to lower-state) varied from about 0.75 to 25. The expected increase of ratio with energy and projectile size was verified. An apparent direct interaction of ^{7}Li projectiles was observed. Calculations of a simple type which considered only the angular momentum distribution of the compound nucleus, and calculations of the Huizenga-Vandenbosh type were performed for the reactions studied. (auth)

24595 DIRECT MEASUREMENT OF NEUTRON TRANSMISSION COEFFICIENTS. Finckh, E.; Jahnke, U.; Pietrzyk, P.; Schreiber, B.; Weidinger, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Rev., C; 1: 700-3(Feb 1970).

Neutron transmission coefficients are determined experimentally by investigation of the neutron decay of isobaric analog resonances (IAR) in the compound nucleus. Assuming a statistical decay of the IAR, the neutron branching ratios to the different final states are determined by the transmission coefficients of the partial waves

allowed by angular momentum and parity conservation. Therefore, knowing the spin and the parity of the resonance and of the final states, the transmission coefficients can be obtained from the measured decay rates. This method is applied to the $^{91}Zr(p,n)^{91}Nb$ reaction. The decay of two pronounced IAR in ^{92}Nb at $E^* = 4.70$ MeV (4^+) and $E^* = 5.30$ MeV (2^+) is studied by the time-of-flight method. The measured transmission coefficients are compared with calculations, using two different optical-model parameter sets. Agreement for all partial waves is obtained by modifying the parameters of Moldauer, Engelbrecht, and Fiedeldey. (auth)

24596 ALPHA SPECTROSCOPY OF ^{212g}At AND ^{212m}At. Reeder, Paul L. (Washington Univ., St. Louis). Phys. Rev., C; 1: 721-6(Feb 1970).

The α decay of ^{212g}At and ^{212m}At to excited states of ^{208}Bi was measured. Half-lives of 0.315 ± 0.003 and 0.122 ± 0.001 sec were determined in agreement with previous work. Out of a possible 28 transitions, 20 α transitions were observed to states in ^{208}Bi below 1.11-MeV excitation. (auth)

24597 INELASTIC TRITON SCATTERING FROM ^{92,94,96}Zr. Flynn, E. R.; Armstrong, D. D.; Beery, J. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 1: 703-13(Feb 1970).

The inelastic scattering of 20-MeV tritons from ^{92}Zr, ^{94}Zr, and ^{96}Zr was studied. The principal objective was to obtain an effective interaction strength to be used in a microscopic description of the excitation of neutron states. Only the lower levels of ^{92}Zr and ^{94}Zr were studied, but because of the paucity of available data on ^{96}Zr, this isotope is studied in a more complete way, with 28 levels and 17 spins assigned. The shell-model results indicate a much smaller effective interaction strength for the excitation of neutron states than noted earlier for proton states in triton inelastic scattering. (auth)

24598 MAGNETIC MOMENTS OF COMPOUND STATES IN ^{168}Er. Beckurts, K. H.; Brunhart, G. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 1: 726-34(Feb 1970).

A polarized-neutron transmission method is used to determine the shift of the neutron resonance energies due to the hyperfine interaction of the compound states. Resonances in ^{167}Er + n at 0.460 and 0.584 eV are investigated. The resonance at 0.584 eV ($J = I - \frac{1}{2}$) shows a strong effect, leading to a very large value of the g_J factor, while g_J for the 0.460-eV resonance ($J = I + \frac{1}{2}$) is in the order of g_I for the ^{167}Er ground state. The results are compared to some recent predictions based on a statistical model of the compound nucleus. The role of nuclear magnetic interference terms which lead to a strong background transmission effect is discussed. (auth)

24599 DETERMINATION OF THE STATIC QUADRUPOLE MOMENT OF THE FIRST 2^+ EXCITED STATE IN ^{142}Ce. Engler, G. (Univ. of Pittsburgh). Phys. Rev., C; 1: 734-5(Feb 1970).

Coulomb excitation of the first 2^+ state in ^{142}Ce was produced by 42-MeV ^{18}O ions. The static quadrupole moment of the first 2^+ excited state and the B (E2, $0^+ \rightarrow 2^+$) were determined. The values were -0.12 ± 0.09 eb and 0.459 ± 0.006 e^2b^2, respectively. (auth)

24600 EXPERIMENTAL LIMITS FOR POLARIZATION OF CONVERSION ELECTRONS. Van Klinken, J.; Schuurman, J. J.; Schuurmans, J. H. (Univ. of Groningen, Netherlands). Phys. Rev., C; 1: 736-7(Feb 1970).

An accurate absolute measurement of the longitudinal polarization of conversion electrons is reported. The investigation was stimulated by a suggestion of Mendels and Wouthuysen on a possible electron polarization in electromagnetic processes. The measurements confirm the general belief that conversion electrons from unoriented sources are not polarized. Values were found for the K- and L-conversion lines of ^{114m}In: $P_c(K) = -0.001 \pm 0.008$ and more accurately: $P_c(L) = +0.001 \pm 0.004$. (auth)

24601 SPONTANEOUS-FISSION DECAY CONSTANT OF ^{241}Am. Gold, Raymond (Argonne National Lab., Ill.); Armani, Roland J.; Roberts, James H. Phys. Rev., C; 1: 738-40(Feb 1970).

The ^{241}Am spontaneous-fission decay constant was determined with solid-state track recorders of pre-etched mica. Measurements were carried out with electroplated ^{241}Am sources. Consistent spontaneous-fission-rate measurements were obtained for a large range of fission track densities over more than a 3-yr period. Systematic error due to source impurities was established as insignificant relative to statistical error. The present experimental result for the ^{241}Am spontaneous-fission decay constant is $\lambda_f = (6.04 \pm 0.13) \times 10^{-15}$ yr^{-1}. (auth)

24602 COMMENTS ON THE PAPER "K X RAYS FROM FISSION FRAGMENTS FORMED IN ASSOCIATION WITH LONG-RANGE ALPHA-PARTICLE EMISSION". Feather, N. (Univ. of Edinburgh). Phys. Rev., C; 1: 747-9(Feb 1970).

It is shown that the yield of even-Z x rays is relatively greater, overall, in the α-particle-accompanied ternary than in the binary fission of ^{252}Cf. A possible reason for this difference is suggested. (auth)

24603 COMPLETE-FUSION CROSS SECTIONS FOR THE REACTIONS OF HEAVY IONS WITH Cu, Ag, Au, AND Bi. Natowitz, Joseph B. (Texas A and M Univ., College Station). Phys. Rev., C; 1: 623-30(Feb 1970).

Mica track detectors were used to detect recoil nuclei from the reactions of ^{12}C, ^{16}O, and ^{20}Ne projectiles with Cu, Ag, Au, and Bi targets. The observed track-length distributions and angular distributions together with detector-threshold information indicate that the observed recoils result from complete fusion of the target and projectile nuclei. The cross section σ_{CF} for the complete fusion mechanism is found to be well below the total-reaction cross section σ_R at the higher projectile energies. A sharp-cutoff model is employed to extract values of J_{crit}, the maximum angular momentum of the compound nuclei formed in complete-fusion reactions. Using those values, complete-fusion cross sections are calculated as a function of the mass of the complete-fusion product for reactions induced by ^{16}O, ^{20}Ne, and ^{40}Ar. Assuming only first-chance fission, the ratio Γ_f/Γ_n has been calculated for the system $^{197}Au + {}^{16}O \rightarrow {}^{213}Fr^*$. (auth)

24604 LARGE-ANGLE ELASTIC SCATTERING OF 1.33-MeV PHOTONS FROM LEAD AND URANIUM. Hardie, Gerald; Merrow, William J.; Schwandt, David R. (Western Michigan Univ., Kalamazoo). Phys. Rev., C; 1: 714-20(Feb 1970).

The differential cross sections for the elastic scattering of 1.33-MeV photons from lead and uranium were remeasured at angles ranging from 60 to 135°, using a lithium-drifted germanium detector. Dispersion relations are used to fix the relative phases among nuclear Thomson, Rayleigh, and Delbrueck scattering. These relative phases and the calculations of the amplitudes for the individual scattering processes permit the theoretical cross sections to be determined. A discrepancy exists between the theoretical calculations and the experimental results. Previous suggestions for removing this discrepancy include incoherence between scattering from the nucleus and from the electrons, and a 180° phase shift between the parallel-polarization components of the nuclear Thomson and Rayleigh amplitudes. These suggestions are discussed and another possibility, destructive interference at large angles between Rayleigh scattering from the K shell and from the L shell, is presented. (auth)

24605 ISOTOPE SHIFTS AND ISOMER SHIFTS IN MUONIC ATOMS. Wu, C. S. (Columbia Univ., New York). pp 367-88 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Recent results on isotope shifts ($^{142-146,148,150}$Nd, $^{92,95-97}$Mo, $^{50,52-54}$Cr) and isomer shifts (^{182,184,186}W) are summarized. First, the merits and disadvantages of the three different isotope shift methods (optical hfs spectra, electronic x-rays and muonic x-rays) are briefly outlined. The sensitivities of model dependence of the observed isotope shifts by these three methods are also introduced and discussed. The main emphasis of the paper is to show and to explain how the muonic isotope shift results may be used to normalize the optical isotope shift results and obtain the specific mass corrections occurring in optical results. The energy shifts of nuclear gamma rays as the result of the dynamic E2 interactions in several deformed nuclei have been precisely measured. The calculated shifts of the center of gravity of the unresolved magnetic doublet are first applied to the observed shifts. The remaining shifts may be interpreted as the isomer effects, i.e., the effect of charge distribution on the transition energy. A comparison of the isomer effects by the muonic atom method and by the Moessbauer technique is included. (auth)

24606 SPONTANEOUSLY FISSIONING ISOMERS. Polikanov, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 449-61 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-6807C2.

A review is given of the basic experimental data which permit some assumptions to be made about the nature of the spontaneously fissioning isomer. Recently, americium isomer production both by neutron radiative capture and stripping reactions with deuterons has been studied. An analysis of the data obtained provided the basis for suggesting "shape isomerism" in the case of the americium fissioning isomers. Some possible experiments permitting a check on the validity of the suggested hypothesis are discussed. (auth)

Nuclear Theory

Refer also to abstracts 23764, 24119, 24179, 24275, 24308, 24398, 24405, 24409, 24413, 24426, and 24530.

24607 (COO-1051-41) ON THE SOLUTION OF THE NUCLEAR THREE BODY PROBLEM IN COORDINATE SPACE. Borysowicz, J. (Michigan State Univ., East Lansing. Dept. of Physics). [28 Feb 1970]. 10p. Dep. CFSTI.

A new method to find the wave functions and binding energy of the three-nucleon system is discussed. Results of the calculations with local, central potentials are given. The wave functions are found to be sensitive to the shape of the nucleon-nucleon potential. The corresponding binding energies differ by less than 0.6 MeV. (auth)

24608 (JINR-P4-4896) QUASI-PARTICLE STATES OF SPHERICAL NUCLEI. Khristov, I. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The role of the pair correlations of the superconducting type in spherical nuclei is studied. Within the framework of the superfluid model the equations are derived for the superfluidity and the energy of excited quasi-particle states taking into account the blocking. The energies and superfluid characteristics of quasi-particle states in the region of mass numbers $100 < A < 150$ are calculated. The blocking effect in spherical nuclei is estimated. (auth)

24609 (JINR-P4-4897) N-N INTERACTION AND THE AVERAGE NUCLEAR FIELD. Babikov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 30p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The main trends and the latest achievements in nuclear forces theory are reviewed. Potential models of interaction in the two-nucleon system and in a heavy nucleus are considered. The role of the heavy mesons in creation of a self-consistent nuclear potential is analyzed. Statistical theories of nuclear matter distribution in finite nuclei are discussed. (auth)

For abstracts of individual papers see: 24502, 24605, 24606, and 24638-24668.

24610 (STI/PUB-189) NUCLEAR STRUCTURE: DUBNA SYMPOSIUM, 1968. Proceedings Series. Invited Papers from the International Symposium held in Dubna, 4-11 July 1968. (International Atomic Energy Agency, Vienna (Austria)). 1968. 651p. (CONF-680702). IAEA $15.00.

Separate abstracts were prepared for 34 of the 36 papers included. The remaining 2 papers have previously appeared in NSA. (J.W.R.)

24611 (UCSD-10-P-11-99) REARRANGEMENT EFFECTS AND THE PARAMETRIZATION OF THE EFFECTIVE FIELD IN NUCLEI. Meldner, H. (California Univ., La Jolla. Inst. for Pure and Applied Science); Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge). [1969]. Contracts AT(11-1)-Gen-10; AT(30-1)-2098. 13p. Dep. CFSTI.

A simple parametrization of the non-local effective field in nuclei is provided. The parameters as determined by fitting the properties of nuclear matter are quite similar to those which have been shown to yield good results for the size and binding energies of finite nuclei throughout the periodic table. It is shown that the self-consistent single-particle energies are significantly different from the separation energies (rearrangement effect) and consequences for structure calculations and particle knock-out experiments are discussed. (auth)

24612 SOME PROPERTIES OF THREE-DIMENSIONAL HARMONIC OSCILLATOR WAVE FUNCTIONS. Talman, James D. (Univ. of Western Ontario, London. Univ. of Copenhagen). Nucl. Phys.; A141: 273-88(1970).

A number of properties of harmonic oscillator wave functions in three dimensions are derived using a generating function technique. The problems treated are the following: the matrix element between harmonic oscillator wave functions of different spring constants, the expansion of the product of harmonic oscillator wave functions in harmonic oscillator wave functions, the transformation between wave functions in spherical and cylindrical symmetry, translational properties of harmonic oscillator wave functions and the calculation of matrix elements of two-particle central potentials. In connection with the last problem, a relatively simple expression for the Talmi bracket is obtained, and an efficient method of calculating two-particle matrix elements is described. (auth)

24613 NUCLEAR-MATTER REACTION MATRIX. Siemens, Philip J. (Cornell Univ., Ithaca, N. Y.). Nucl. Phys.; A141: 225-48(1970).

Accurate numerical solutions to the Bethe-Goldstone equation are obtained for nuclear matter with different densities of neutrons and protons, starting with Reid's soft-core potentials. The lowest-order binding energy, with a phase-shift approximation for states of high J, is -11.1 MeV at saturation density $k_F = 1.44$ fm^{-1}. The symmetry coefficient is 31 MeV. A new density-dependent local interaction potential for use in finite nuclei is obtained from the calculation. (auth)

24614 MULTI-NUCLEON TRANSFER REACTIONS. El-Nadi, M.; Sharaf, M. A. (Univ. of Cairo). J. Phys., A (London); 3: 179-89(Mar 1970).

A method is developed for the calculation of the matrix element for any nuclear reaction in which n nucleons are transferred from the projectile to the target nucleus. As an example, the matrix element for the four-nucleon transfer reaction is derived in the Born approximation. Comparison with the experimental angular distribution for the reaction $^{12}C(d,^6Li)^8Be$ is carried out in both the diffraction and the plane wave models and the results are compared with the experimental data. (auth) (UK)

24615 STATISTICAL THEORY OF DEFORMED NUCLEI. Brueckner, K. A.; Clark, R. C.; Lin, Wing-fai; Lombard, R. J. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-GEN-10. Phys. Rev., C; 1: 249-54(Jan 1970). (UCSD-10-P-11-96).

The changer in binding energy of $_{114}X^{298}$ under deformation into prolate spheroidal shapes were calculated using the statistical theory of nuclei. The density is restricted only by the requirement that each equidense surface is a spheroid. It is found that the energy is minimized when the density has an approximately uniform surface thickness around the nucleus. To first order the change in binding energy is given well by the liquid-drop model, but at large deformation the statistical theory predicts less drop in energy and, consequently, a slightly more stable nucleus. (auth)

24616 SELF-CONSISTENT CALCULATION OF p-SHELL HYPERNUCLEAR BINDING ENERGIES. Bassichis, W. H.; Gal, A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., C; 1: 28-34(Jan 1970).

Calculations of the binding energies of p-shell hypernuclei were carried out treating all the nucleons and the Λ self-consistently. The Tabakin potential is used for the NN interaction and a simple central force which fits ΛN scattering is used for the Λ-N system. The binding energies obtained exceed those observed. The dynamical aspects of the hypernuclear system are also discussed, as well as various correction terms. Finally, a comparison is made with other hypernuclear calculations. (auth)

24617 NUCLEAR FORCES AND NUCLEAR ENERGETICS. Ingber, Lester; Potenza, Robert M. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-GEN-10. Phys. Rev., C; 1: 112-22(Jan 1970). (UCSD-10-P-11-94).

Both a static and a momentum-dependent potential are derived from one-meson-exchange Born amplitudes, and are adjusted to fit (i) the deuteron binding energy and quadrupole moment, (ii) S, P, and D partial waves from 25 to 310 MeV, and (iii) the binding energy and saturation property of nuclear matter. This is possible through a different form of the central and tensor potentials which has not been used previously to calculate problems (i), (ii), and (iii) above. The σ meson is unsuitable to describe the two-pion-exchange region in that a potential with meson parameters common to all partial waves is not achieved. (auth)

24618 NEW STATISTICAL THEORY OF THE NUCLEAR SURFACE. I. Siemens, Philip J. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., C; 1: 98-111(Jan 1970).

The Thomas-Fermi integral theory of the nuclear surface is shown to have singular solutions for the nuclear density. This failure is traced to its inadequate representation of the behavior of wave functions in a potential. A new theory based on approximate wave functions is developed and shown to be asymptotic to the Thomas-Fermi theory in the interior of the nucleus. An improved treatment of exchange forces is shown to be essential to obtaining realistic solutions. (auth)

24619 TREATMENT OF THE THREE- AND FOUR-NUCLEON SYSTEMS BY A GENERALIZED SEPARABLE-POTENTIAL MODEL. Alt, E. O.; Grassberger, P.; Sandhas, W. (Univ., Bonn). Phys. Rev., C; 1: 85-98(Jan 1970).

A formalism, proposed previously, which represents a generalization of the separable-potential model is applied to the four-nucleon system. It consists essentially in approximating the off-shell nucleon-deuteron scattering amplitude—as obtained in the separable-potential model—again by separable expressions. Effective two-particle equations which are solvable by standard methods are obtained. The determination of the required separable terms is studied in detail. A first attempt to solve approximately the final

integral equations is made. The results demonstrate the applicability of the method. (auth)

24620 HARTREE–FOCK CALCULATIONS OF EVEN–EVEN N = Z NUCLEI. Krieger, S. J. (Univ. of Illinois, Chicago. Oak Ridge National Lab., Tenn.). Phys. Rev., C; 1: 76-84(Jan 1970).

Hartree–Fock calculations were performed for the even–even N = Z nuclei from A = 4 to A = 40. The calculations use a velocity-dependent interaction which contains two-body spin-orbit and tensor terms, and which was especially derived for use in HF calculations. Effects of truncation are made minimal by using a basis of Cartesian harmonic-oscillator wave functions. Nuclear sizes and single-particle energies are in reasonable agreement with experiment; however, total binding energies are much too small. Comparison is made with other recent calculations. (auth)

24621 STRUCTURE OF THE NUCLEON–NUCLEUS SCATTERING MATRIX IN THE RANDOM-PHASE APPROXIMATION. Ginocchio, J. N.; Schucan, T. H.; Weidenmueller, H. A. (Yale Univ., New Haven). Contracts AT(30-1)-3223; AT(30-1)-2726. Phys. Rev., C; 1: 55-75(Jan 1970).

The scattering matrix is derived for the scattering of nucleons by nuclei lacking one nucleon from being doubly magic. It is assumed that an average field has been determined through a Hartree–Fock procedure (HF). The residual interaction is treated in the random-phase approximation (RPA). In contrast to previous treatments, it is not assumed that this interaction is separable. The RPA ground state of the compound system is given by a correlated wave function $|\Psi_0\rangle$. It is assumed that states of the target and residual nucleus can be described as one-hole states in this correlated ground state $|\Psi_0\rangle$. It is found that the RPA equations allow for a proper definition of asymptotic states only if the full Hamiltonian (including the c.m. energy) is used in the HF procedure. A general, yet explicit, expression for the S matrix is obtained by applying to the channel–channel part of the residual interaction a method first proposed by Weinberg. The correlations contained in $|\Psi_0\rangle$ give rise to poles of the scattering matrix for real negative energies below the energy of the lowest bound state, i.e., the ground state $|\Psi_0\rangle$. In the energy region of physical interest, these poles have two effects on the scattering matrix. First, a constant background term is introduced. Second, the partial widths $\Gamma_{\lambda c}$ for decay of a compound state (λ) into an open channel (c) are complex. The sum of the partial widths, $\Sigma_{\lambda c}\Gamma_{\lambda c}$, is compared with the sum of the total widths, $\Sigma_\lambda \Gamma_\lambda$. It is found that the two sums differ by terms of second order in the admixture of correlations in the ground state. The influence of symmetry properties of the Hamiltonian on the RPA solutions is discussed. It is shown that the scattering matrix derived is that in the c.m. frame, and it is completely independent of the total momentum of the nucleus. (auth)

24622 GENERAL METHOD FOR HANDLING THE HARD CORE WITH SHELL-MODEL WAVE FUNCTIONS. Palumbo, F. (CNEN, Rome. Univ., Rome). Phys. Rev., C; 1: 129-37 (Jan 1970).

The left-unitary operators that introduce the correlations of the hard core in an uncorrelated bound-state wave function of a finite number A of particles are explicitly determined up to a unitary transformation. Left unitarity is required in order to keep orthonormality. Using a shell-model basis, transformed according to the correlation operator, it is possible to diagonalize the Hamiltonian in a subspace of the full Hilbert space with the technique of Bloch and Horowitz. Ground as well as excited states are treated on the same footing. In practice, the diagonalization is accomplished using the original single-particle basis and transforming back the Hamiltonian. This results in an A-body operator for which a cluster expansion is possible. In this cluster expansion, there are three- and four-body terms easy to evaluate, because they factorize. A particularly interesting application can be made to few-body systems, evaluating the integrals numerically. The unique approximation is then connected with the cut of the basis. The method developed seems comparatively simple and is free of the mathematical problems of the hard core. (auth)

24623 GENERALIZED VARIATIONAL BOUNDS FOR MULTICHANNEL SCATTERINGS. Hahn, Yukap (Goddard Space Flight Center, Greenbelt, Md. Univ. of Connecticut, Storrs). Phys. Rev., C; 1: 12-16(Jan 1970).

The variational bounds on scattering parameters are reformulated without the explicit use of multichannel projection operators, thus avoiding completely the difficulty of nonorthogonality in rearrangement and exchange collisions. Resonance-energy calculations can be carried out using the operator which is effectively projected on the closed channels. (auth)

24624 STATISTICAL-MODEL CALCULATION OF THE ANGULAR DISTRIBUTIONS OF (α, n) REACTION PRODUCTS. Swanson, D. G.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 1: 4-11(Jan 1970).

A calculation of the angular distribution of recoil products resulting from compound nuclear (α, n) reactions was programmed on the basis of the spin-dependent statistical theory of nuclear reactions. The program, which is based on the Monte Carlo technique, considers the emission of neutrons, protons, α particles, and γ rays, and uses either the Fermi-gas or the superconductor model of the nucleus. The computed angular distributions were compared with the experimental results for various (α, n) reactions and, in agreement with experiment, exhibit a smooth dropoff from a peak close to 0°. This contrasts with the marked disagreement between the experimental results and previous spin-independent calculations, which predicted a peak at large angles to the beam. The difference is ascribed to the effect of competitive γ-ray emission, which is not adequately considered in spin-independent calculations. The present calculation predicts a faster decrease with angle in the magnitude of the differential cross section than is observed experimentally. This result is independent of the specific parametrization of the calculation and may reflect a small contribution from direct interactions. (auth)

24625 SINGLE-PARTICLE RESONANT-STATE WAVE FUNCTIONS IN A SIMPLE DESCRIPTION OF ISOBARIC ANALOG RESONANCES. Gyarmati, B. (Inst. of Nuclear Research, Debrecen, Hungary); Vertse, T.; Zimanyi, J.; Zimanyi, M. Phys. Rev., C; 1: 1-3(Jan 1970).

An example is given for the use of single-particle resonant-state wave functions in describing nuclear-resonance phenomena. The resonant-state functions are generated by solving numerically the one-body Schrödinger equation with pure outgoing asymptotics. The Lane-model Hamiltonian of the target + nucleon system is diagonalized on a basis consisting of bound-neutron and resonant-proton wave functions. The agreement with the result obtained by the exact integration of the coupled Lane equations is good. (auth)

24626 ANALYSIS OF THREE-PARTICLE FINAL-STATE INTERACTIONS. Salyers, Abigail Ann. Washington, D. C.; George Washington Univ. (1969). 142p.

Thesis.

Two methods —a model calculation and unitarity arguments are utilized in the analysis of reactions involving three particle final states. The Dirac approach to resonant scattering is used to obtain a closed form solution for the three particle wave function and thus for transition matrix elements in which three particle states occur. Similarly, unitarity and analyticity arguments are used to obtain a general form for scattering matrix elements as functions of the total and two particle energies. This form is seen to be equivalent to that obtained by the Dirac model, even though the Dirac model deals with a more restricted situation. This expression for the scattering matrix element is applied in the calculation of the energy spectrum of an outgoing alpha particle in the reaction $^{12}C \rightarrow 3\alpha$ and in the calculation of the differential cross section in the reaction $\gamma + {}^9Be \rightarrow n + \alpha + \alpha$. In both cases, theoretical results give a good fit for experimental data. (Diss. Abstr. Int., B)

24627 SPIN–ORBIT SPLITTING EFFECT ON SINGLE-PARTICLE ENERGY LEVELS BASED ON VELOCITY-DEPENDENT POTENTIAL. Lodhi, M. A. K. (Texas Tech Univ., Lubbock). Phys. Rev., C; 1: 365-6(Jan 1970).

The single-particle energy states of neutrons calculated for several finite nuclei are found in good agreement with the experimental data. An effective velocity-dependent nucleon-nuclear potential based upon the N-N interaction was employed in the independent-particle model, and the spin-orbit effect has been studied. (auth)

24628 TWO-NUCLEON TRANSFER REACTIONS. Harris, Samuel M. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Phys. Rev., C; 1: 362-4(Jan 1970).

Assuming isospin conservation, an analysis was performed of the two-nucleon transfer reactions (p,t) and (p,^{3}He) on a target with isospin T_i going to analog final states with $T_f = T_i$. Formulas for the relevant cross sections are given which explicitly show the isospin dependence of the transferred pair. When restricted to T = 1 pair transfer, the result is more general than that recently derived by Hardy, Brunnader, and Cerny. (auth)

24629 OFF-ENERGY-SHELL t MATRIX FOR LOCAL POTENTIALS WITH SINGULAR CORE INTERACTIONS. Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 1: 414-22(Feb 1970).

As a preliminary to studying three-body problems involving local two-particle potentials with singular core interactions, an integral equation for the complete off-energy-shell t matrix for the associated two-particle scattering is derived. The core interaction is described by the boundary-condition model (specified energy-independent logarithmic derivative of the radial wave function at the core radius). Numerical solutions of the integral equation for the special case of the Herzfeld potential (hard core

with a square well outside) are found to agree well with the exact t matrix. (auth)

24630 ABSORPTION, CHARGE-EXCHANGE, AND DOUBLE-CHARGE-EXCHANGE REACTIONS OF π MESONS WITH COMPLEX NUCLEI: COMPARISON OF THEORETICAL PREDICTIONS WITH EXPERIMENTAL RESULTS. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 1: 423-35(Feb 1970).

The two-step intranuclear-cascade evaporation model is used in the calculation of nucleon spectra, particle multiplicities, and radiochemical cross sections following stopped-π^- absorptions by complex nuclei. The nucleon spectra and particle multiplicities from the pion absorption by light elements are, in general, predicted quite well. The theoretical particle yields from the heavy elements are overestimated and the particle spectra are too soft. These discrepancies are attributed to an insufficient number of pion absorptions near the edge of the nucleus for the heavy elements in the theoretical model. The magnitudes of the theoretical radiochemical cross sections from slow-π^- absorption by iodine are in fair agreement with those from experiments, but the peak in the cross-section distribution versus isotope mass for some of the isotopes appears at lower mass values than the measured ones. This discrepancy is consistent with those above. The model does well in predicting the charge-exchange cross section, but does poorly in estimating the double-charge-exchange cross section for pions with energies below 200 MeV. These cross sections represent about 1% or less of the total interaction cross section, and the theoretical model does not accurately reproduce such events, in general. (auth)

24631 REMARKS ON MOMENT-OF-INERTIA CALCULATIONS IN HEAVY NUCLEI. Wong, S. K. M.; Trainor, L. E. H.; Ng, W. Y. (Univ. of Toronto). Phys. Rev., C; 1: 743-4(Feb 1970).

It is shown that the work of Varma et al., entitled "Comments on a Recent Paper on Moments of Inertia in Heavy Nuclei," is based on a misconception about our previous work and contains a basic error. (auth)

24632 PROLATE–OBLATE DIFFERENCE AND ITS EFFECT ON ENERGY LEVELS AND QUADRUPOLE MOMENTS. Kumar, Krishna (Oak Ridge National Lab., Tenn. Univ. of Copenhagen). Phys. Rev., C; 1: 369-71(Feb 1970).

From the microscopic calculation for the W, Os, and Pt nuclei, semiquantitative relations are obtained among the prolate–oblate difference of the potential energy of deformation, the 2_γ^+ and 4^+ level splitting, and the static quadrupole moment Q_γ^+. These relations are applied to ^{24}Mg, ^{56}Fe, ^{110}Cd, and ^{152}Sm. The important role of the $\beta-\gamma$ dependence of the mass parameters is demonstrated. (auth)

24633 COMMENTS ON A RECENT PAPER ON MOMENTS OF INERTIA IN HEAVY NUCLEI. Varma, S.; Plattner, G. A.; Das Gupta, S. (McGill Univ., Montreal). Phys. Rev., C; 1: 741-2 (Feb 1970).

Contrary to the conclusions reached in a recent paper, it is found that for the usual combination of long-range and pairing force that is used for calculations in heavy nuclei, the Belyaev–Inglis formula for moment of inertia is adequate and gives values close to those obtained from projection methods. (auth)

24634 PERTURBATIVE APPROACH FOR THE GROUND-STATE CORRELATIONS OF VIBRATIONAL NUCLEI. Ullah, Nazakat (Univ. of Toronto). Phys. Rev., C; 1: 408-10(Feb 1970).

An approximate procedure which makes use of the spherical Hartree–Fock method and the perturbation approximation is described for generating the correlated ground state. This procedure is compared with an exact shell-model method and with the projected Hartree–Fock (PHF) method, with or without time-reversal constraint, by studying the octupole correlations in ^{16}O. It is shown that the results given by the present simple method are comparable with the more difficult PHF method with no time-reversal constraint. (auth)

24635 ELECTRON SCATTERING FROM DEFORMED NUCLEI. Raphael, R. (Naval Research Lab., Washington, D. C. Catholic Univ. of America, Washington, D. C.); Rosen, M. Phys. Rev., C; 1: 547-60(Feb 1970).

A general phenomenological theory is developed for the calculation of both elastic and inelastic transverse and longitudinal form factors for electron scattering from nuclei whose surfaces are deformed according to the expression $R + (4\pi)^{\frac{1}{2}}\Sigma_{lm}\hat{a}_{lm}Y_{lm}(\hat{r})$. Here, the $\hat{a}_{lm}$ are operators in the nuclear Hilbert space, whose detailed dynamical character is left unspecified. The effects of deformation on the scattering, to any desired accuracy, are contained in reduced matrix elements of tensor products of the $\hat{a}_{lm}$. These are then treated as phenomenological parameters whose values are to be fixed from an analysis of the scattering cross sections, particularly at high momentum transfer. All the static and transition multipole moments of the nucleus are thereby determined, at least in principle. The Helm model and its generalization to transverse scattering are obtained in the small-deformation limit. The theory is used to analyze the Coulomb elastic and inelastic (to the 1.3-MeV $\frac{3}{2}^+$ level) scattering of electrons from ^{59}Co, as well as the magnetic elastic and inelastic scattering from ^{10}B. It is shown that the contribution of the deformation to elastic monopole scattering may be interpreted as due to an effective, oscillatory, spherically symmetric "modulating-charge" distribution, superimposed upon the more usual smeared uniform distribution. It is therefore suggested that the oscillations in the charge distribution which seem to be required in order to fit the high-energy elastic scattering from ^{40}Ca and other nuclei may be due to deformations. (auth)

24636 GENERALIZATION OF THE MODIFIED WKB APPROXIMATION FOR PHASE SHIFTS. Lu, Pao (Arizona State Univ., Tempe). Phys. Rev., C; 1: 468-9(Feb 1970).

A generalization of the modified WKB method proposed by Good and by Rosen and Yennie as applied to the scattering problem is presented. In the formulation of this problem the main equation connects two parts, the solved part and the part to be solved. We consider not only the case where the radical wave function of the solved part has the form of the three-dimensional free-particle solution, as is done by the authors mentioned above, but also where it has the form given by an explicit solution with a known potential. The closer the resemblance between the potentials of the unsolved and the solved parts, the better the result is. (auth)

24637 DIFFRACTION MODEL OF FIRST- AND SECOND-ORDER DIRECT NUCLEAR REACTIONS. Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 1: 385-91 (Feb 1970).

The Hankel-transform (impact-parameter representation) method is used to simplify the derivation of the diffraction model of direct nuclear reactions. Both first- and second-order processes (represented by pole, triangle, and box diagrams) are discussed, and relatively simple formulas for the corresponding diffraction-model amplitudes are given. Inclusion of Coulomb effects and the extension to backward-peaked processes are also discussed. (auth)

24638 ONE-PARTICLE MOTION IN SPHERICAL NUCLEI. Cohen, B. L. (Univ. of Pittsburgh). pp 3-14 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB–189; CONF-680702.

New information on locations of single-particle states as determined by single-nucleon transfer reactions and elastic proton scattering through isobaric analog states is summarized. The situation with neutron single particle states is reasonably satisfactory although there is considerable uncertainty about the particle states in N = 83 nuclei. Information on proton single-particle states has accumulated rapidly recently. The single-particle level structure is very similar for neutrons and protons in nuclei of the same mass number A, more so than for either one at very different A. The principal A-dependence is that high-j states move downward rapidly relative to low-j states with increasing A, for well understood reasons. Information on imperfect major shell closure at "magic numbers" is summarized, and it is pointed out that it is not unexpected. The only really good closed shell nuclei are those near ^{208}Pb. The significance of deep-lying hole states found in (e,e'p) reactions is mentioned. Information on neutron single quasi-particle states in the 28-50 and 50-82 shells is reviewed. Experiments are now available on non-single-closed shell nuclei in the latter region; fragmentation of single quasi-particle states is somewhat larger than heretofore encountered, but there is generally one nuclear state that contains a large fraction of their strength. An important difficulty is encountered in the $g_{\frac{9}{2}}$ and $h_{\frac{11}{2}}$ states where results from the stripping and pickup reactions differ greatly in nuclei between Mo and In. Plots of the "degree of emptiness," U_j^2, and of single quasi-particle energies, E_j, are given for all single-particle states for nuclei with N = 28-82, and comparisons are made with pairing theory predictions. In general, the agreement is good although there are several difficulties that are discussed. (auth)

24639 TWO- AND THREE-QUASIPARTICLE STATES IN SPHERICAL NUCLEI. Alexander, K. F. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 15-26 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB–189; CONF-680702.

From the experimental study of two- and three-quasi-particle states in spherical nuclei useful information can be obtained on the

residual interaction between quasiparticles. Such states can be assumed to be relatively pure, if they have the maximum possible spin value. Experimental data on several maximum spin states are discussed. Possible causes for the hindrance of electromagnetic transitions deexciting 2 qp and 3 qp states are pointed out. A further tool to investigate the quasiparticle structure of excited states is the analysis of allowed beta decay. This is demonstrated, for example, with the 4^+ states of the even Sn isotopes. The residual proton-neutron interaction can considerably shift 3 qp states if strongly interacting proton and neutron orbitals are involved. This effect is studied in detail for states in which the structure $(\pi g_{9/2}\nu g_{7/2})_{1+}$ is present. (auth)

24640 QUASIPARTICLES AND NUCLEAR VIBRATIONAL STATES. Sorensen, R. A. (Carnegie-Mellon Univ., Pittsburgh). pp 27-38 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The level structure associated with various nuclear vibrations is described. It is shown how these vibrations are described in terms of particle or quasiparticle excitations by means of the harmonic random phase approximation. Vibrations corresponding to different modes of excitation are compared. Motions corresponding to the enhancement of three different simple operators are considered: (a) the E2 one-body operator, (b) the operator causing the removal or addition of a like, zero-coupled pair of nucleons from the nucleus, and (c) the operator for allowed beta decay which changes one proton to a neutron or one neutron to a proton. (auth)

24641 EXCITED STATES WITH SMALL SPINS IN EVEN-EVEN DEFORMED NUCLEI. Dzhelepov, B. S. (Radium Inst., Leningrad); Shestopalova, S. A. pp 39-57 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The properties of 0^+, 2^+, 1^- and 1^+ states in even-even deformed nuclei of average weight ($150 < A < 194$) are discussed. All available information is used, but the paper is based mainly on information on the numerous excited states of these types occurring in the nucleus of ^{170}Yb. Attention is drawn particularly to the fact that several 0^+ states in the 1-2 MeV range can be detected in a number of nuclei (for example, in ^{164}Er there are five; in ^{170}Yb there are four; in ^{178}Hf there are three). The existing theories and hypotheses on the origin of 0^+ states are examined. At the present time it is not clear how observed and theoretical states can be compared, since no criteria have yet been developed for this purpose. A summary is made of all that is known of these criteria and an attempt is made to classify certain 0^+ states. Data are described on twelve ^{170}Yb states with $I^\pi = 1^-$ and the transitions between them. From seven states of the 1^+ type in ^{170}Yb, a single rotational pair of levels 1^+ and 2^+ is detected. (auth)

24642 ANALYSIS OF QUADRUPOLE AND OCTUPOLE COLLECTIVE STATES IN EVEN-EVEN NUCLEI. Vogel, P. (Inst. of Nuclear Research, Rez, Czech.). pp 59-70 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The collective vibrational states of even-even nuclei are investigated. The mathematical technique used is the quasiparticle random phase approximation. Information on the residual interaction obtained by the analysis of the calculations is discussed. The interaction constants of the residual multipole-multipole interaction used in different calculations are compared. Their closeness seems to indicate that a rather universal multipole-multipole force especially suitable for treatment of the vibrational states exists. The multipole-multipole force and the other schematic force — the surface delta interaction (SDI) — are compared. It is suggested that the main characteristics of the collective states (energy, $B(E\lambda)$ value) are insensitive to the radial form of the residual interaction. Calculations of the octupole states in the spherical nuclei with the multipole-multipole force, the SDI and the usual δ-force seem to support this assumption. Results of new calculations of the vibrational states in rare-earth deformed nuclei are reported. The deformed Woods-Saxon potential instead of the Nilsson one was used. The description of the $K^\pi = 2^+$ states is satisfactory while agreement between simple theory and experiment for the octupole states is not so good. (auth)

24643 EXPERIMENTAL DECOMPOSITION OF THE WAVEFUNCTIONS OF DEFORMED NUCLEAR STATES INTO THEIR COMPONENTS. Sheline, R. K. (Florida State Univ., Tallahassee). pp 71-100 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Increasing experimental and theoretical evidence for the complexity of low-lying states in deformed nuclei suggests the need for a variety of experimental approaches. The available experimental methods are summarized with particular emphasis on multi-reaction spectroscopy as a method of separating various components in the structure of deformed nuclear states. Level structures and other experimental parameters of ^{162}Dy, ^{177}Hf, ^{175}Lu and ^{177}Lu agree well with the Nilsson Model and the calculations of Soloviev as is typical of the most strongly deformed nuclei. Emphasis is placed on nuclei in the transition region between spherical and deformed nuclei where experiment is expected to test the theory most severely. Experimental data on ^{153}Sm, ^{155}Gd, ^{186}Re and ^{181}Hf indicate the presence of strong coriolis coupling, of mixing of principal harmonic oscillator shells ($\Delta N = 2$ mixing) and of complex phonon admixtures in low-lying states which probably require more sophisticated theoretical analysis. (auth)

24644 INTERACTION OF QUASIPARTICLES WITH PHONONS IN DEFORMED NUCLEI. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 101-18 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The effect of the interaction of quasiparticles with phonons on the structure of the ground and excited non-rotational states of deformed nuclei is investigated. It is noted that both the lowest-lying quasiparticle and one-phonon states are pure enough. The admixture of the two-phonon components to the one-phonon states increases in nuclei of the transition regions as compared to the strongly deformed nuclei. It is shown that with increasing excitation energy the structure of quasiparticle states becomes more complex, i.e., the role of the admixtures becomes more important. The 1-, 2- and 3-quasiparticle components are distributed among a number of non-rotational nuclear levels. As a result, at an excitation energy of 2 MeV and still higher, the number of non-rotational states observed should be greater than that which follows from the independent quasiparticle model. To find the structures of these states a complex experimental study combining alpha, beta and gamma spectroscopy with direct nuclear reactions is needed. (auth)

24645 SYSTEMATIC FEATURES OF NON-ROTATIONAL STATES IN THE ODD-A DEFORMED NUCLEI. Reich, C. W. (Idaho Nuclear Corp., Idaho Falls); Bunker, M. E. pp 119-38 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Some results are presented of a comprehensive survey of the experimental data concerning the non-rotational states of the odd-A deformed nuclei in the rare-earth region. The ordering and relative energy spacings of the one-quasiparticle states in these nuclei are in quite good agreement with the predictions of the Nilsson model. It is shown, however, that the observed spacings of these states are smaller by a factor of ≈ 2 than those calculated from this model. At energies of only a few hundred keV, strong mixing is found between the one-quasiparticle states and states of vibrational character. This phenomenon, which is more pronounced in the odd-neutron nuclei than in the odd-proton nuclei, exhibits systematic features that are exemplified by the observed behavior of the $K = 1/2$ states of complex structure. Other types of mixing that complicate the analysis of the level structure in this region are (1) mixing of states arising from different major shells (N-mixing) and (2) mixing induced through coriolis coupling. For those aspects of N-mixing that are discussed, it is shown that the Nilsson model seriously underestimates the magnitude of this effect. The ground-state rotational band of ^{161}Dy and the positive-parity states of ^{155}Gd are used as examples where the effects of coriolis coupling are especially striking. Cases where discrepancies between the predicted magnitudes of the coriolis-coupling matrix elements and those obtained empirically are pointed out. Difficulties in making detailed configurational assignments to the higher-lying (>0.5 MeV) states of these nuclei are illustrated in terms of the well-studied case of ^{163}Dy. (auth)

24646 NUCLEAR DEFORMABILITY AND QUADRUPOLE MOMENTS. Davydov, A. S. (Inst. for Theoretical Physics, Kiev). pp 139-54 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

A survey of the present phenomenological theory of collective excited states in spherical and non-spherical even-even nuclei is made. It is shown that the character of excited states depends essentially upon the two parameters specifying the nuclear equilibrium shape in the ground state as well as two other dimensionless parameters specifying the longitudinal and transversal deformability of the nuclear surface. Relative to these parameters the nuclei are subdivided into rigid and soft nuclei. In the soft nuclei the rotations are not separated from the vibrations. The above parameters are computed from the data concerning energies of three excited levels. The reduced transition probabilities for E2-transitions between excited states are also expressed in terms of these parameters. Sum rules for reduced E2-transition probabilities and expectation values of quadrupole moments in excited states are discussed. It is shown that the theory of non-spherical deformable nuclei yields expectation values of the quadrupole electric moments of the first 2^+ excited state in good agreement with experimental data for isotopes of the nuclei Cd, Ba, Sm and Gd. (auth)

24647 THE MICROSCOPIC MODELS OF COLLECTIVE EXCITATIONS: PRESENT STATUS AND POSSIBLE WAYS OF IMPROVEMENT. Belyaev, S. T. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp 155-68 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Possible generalizations of the known collective excitation models in the following directions are analyzed: (a) inclusion of other kinds of interactions, generating new types of oscillations, (b) improvement of the quasiboson approximation. The classification of excitations according to the quantum numbers of correlate pairs provides the basis for the corresponding classification of the elementary interactions generating these excitations. For low excitations the number of important "generating interactions" is not large and practically all of them have been tested. A special study is made of the particle-particle channel where "elementary interactions" can be introduced without any new parameters, if the hypothesis of gauge invariance of nucleon-nucleon interaction is used. Additional (to usual pairing) interaction in the particle-particle channel generates 0^+-states—"coherent pairing fluctuation"—having a uniquely large probability ratio of E0 and E2 transitions into the ground band. The experimental identification of such states is of great interest. The necessity to reject the quasiboson approximation is dictated by the complicated vibrational-rotational structure of experimental nuclear spectra. The main difficulty of their theoretical description is the absence of a consistent microscopic picture of rotational excitations. Only in very special models can the group theory be applied and show how rotation appears in the system of interacting particles. A method worked out by Belyaev and Zelevinsky is considered, which gives the possibility of a microscopic description of rotations. The proposed method includes some aspects of group theory approach that, together with the equations of motion for pair operators, allow the consideration of realistic models in a sufficiently good approximation. The illustration of the method serves to obtain the rotational spectrum for j^N configuration with a further generalization on an arbitrary number of levels (in the model with quadrupole interaction). The microscopic structure of rotational states obtained corresponds to the coherent contribution of all the j-levels in rotation and can be directly linked with a visual picture of a deformed nucleus. The wave-function found does not confirm the "stretch scheme" model of Danos and Gillet. (auth)

24648 PROPERTIES OF SOME EXACT SOLUTIONS OF THE PAIRING FORCE PROBLEM. Rasmussen, J. O. (Univ. of California, Berkeley). Contract AT(11-1)-34. pp 169-78 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

In this paper are considered the 0^+ ground and excited states of even systems of nucleons interacting by a pure pairing force. The lowest four roots of exact matrix diagonalization are calculated for the even tin nuclei. Among other things a remarkable behavior of two-nucleon transfer probabilities near subshells, such as 64 neutrons, is found. Namely, only near subshells does collective enhancement of pair transfer occur to excited as well as ground states. For ^{114}Sn at the closed subshell this enhancement occurs for the first excited 0^+ state and this behavior is the measure of the "pairing vibrational character." The enhancement moves unsymmetrically to higher roots for neighboring nuclei on either side of the subshell. Noting the strong dependence of nuclear properties on particle number near subshells, it is suggested that quasi-particle methods not conserving particle number may be unreliable when the Fermi energy is near irregularities in nucleon orbital spacing. Further theoretical studies using particle-number-conservation and realistic reaction-matrix interactions are much needed as well as further experimental information on excited 0^+ states and pair-transfer reactions. (auth)

24649 PAIR CORRELATIONS AND DOUBLE TRANSFER REACTIONS. Bohr, A. (Univ. of Copenhagen). pp 179-89 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

A discussion is given of the collective modes of excitation of the nuclear pairing field, on which experimental evidence from the two-nucleon transfer reactions is accumulating. In regions of closed shells, the excitations have a vibrational character. The neutron 0^+ pair vibrations around ^{208}Pb are considered in the harmonic approximation and with the inclusion of interaction effects between the quanta of excitation. The relation between the vibrational treatment of pair correlations and the treatment of superfluidity (dynamic and static pairing) is compared with the relation between vibrational and rotational descriptions of shape oscillations. The role of the isospin of the pairs is discussed with special attention to the spectrum of 0^+ pairing modes based on ^{56}Ni. When the isospin degree of freedom is included, a static pairing (superfluidity) produces a deformation in isospace, with a resulting rotational spectrum in isospace. Finally, the coupling between particles and pair vibrational quanta is briefly discussed. (auth)

24650 EXPERIMENTAL STATUS OF TWO-NEUTRON TRANSFER REACTIONS IN MEDIUM AND HEAVY NUCLEI. Nathan, O. (Univ. of Copenhagen). pp 191-200 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The systematics of the strong L = 0 transitions observed in two-nucleon transfer reactions in the mass regions near N = 126 and N = 28 is discussed within the framework of the pairing vibrational model of Bohr. Near ^{208}Pb, the evidence consists of (t,p) and (p,t) data for the even-even Pb nuclei, and for ^{209}Pb and ^{207}Tl. Near N = 28, the pairing vibrational spectrum is expected to have a characteristic isospin structure. The evidence for this structure is reviewed on the basis of recent (p,t), (t,p), and (^{3}He,p) data, with particular emphasis on the mass-56, mass-52, and mass-48 nuclei, for which the data are most abundant. Tentative identifications of pairing vibrational 0^+ states are made for the nuclei ^{58}Ni, ^{56}Co, ^{52}Mn, ^{52}Cr, ^{50}Ti, ^{48}V, ^{48}Ti, and ^{48}Ca. In the lighter Ca isotopes, the pairing vibrational strength seems to be fragmentated and the simple zero-order picture breaks down. It is suggested that the model might be extended to comprise also 2^+ excitations built upon the pairing vibrational states. Possible candidates for such pairing-quadrupole states are indicated by (t,p) data for ^{48}Ca, ^{50}Ti, ^{52}Cr, and ^{208}Pb. The energies and intensities of these L = 2 transitions are, however, in poor agreement with a zero-order picture and indicate the presence of considerable mixing effects. The success of the model for the classification of strong L = 0 and L = 2 transitions in two-nucleon transfer reactions near closed shells cannot be assessed in detail from the present scanty data material. Further experiments, which emphasize the measurement of relative transition probabilities in two-nucleon transfer reactions, are strongly indicated. Evidence concerning pairing vibrational transitions near N = 50 and N = 52 would also be highly desirable. (auth)

24651 INELASTIC SCATTERING OF NUCLEAR PARTICLES AND THE STRUCTURE OF VIBRATIONAL NUCLEI. Tamura, T. (Oak Ridge National Lab., Tenn.). pp 213-32 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

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Recent work on the scattering of nuclear particles by spherical nuclei is reviewed. The elastic scattering data have been used in fixing the optical parameters, but the recent tendency is to go one step further beyond the simple parametrization, and so far it has been done for the real part. Existence of some ambiguity in the strength W_D of the imaginary part is pointed out in connection with the one-step inelastic processes, and the importance of more basic theories is invoked. Excitation of the two-phonon states is discussed in some detail using data of Cd(p,p′) and a lack of parallelism between the (p,p′) process and the Coulomb excitation is stressed. It is also shown, however, that this parallelism may be recovered if the use of different W_D in different channels could be justified. Analyses of (p,p′) data from odd-A spherical nuclei, and some recent work on inelastic processes from deformed nuclei, are also discussed. Finally, a brief account is given of the pos-

sible analyses of the (p,p') data via isobaric analog resonance. An outline is given of such a theory based on the shell model approach to nuclear reactions. (auth)

24652 COLLECTIVE STATES IN CONTINUUM. Balashov, V. V. (Moscow State Univ.). pp 233-46 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

An analysis of the state of theory describing collective excitations of nuclei in the region of the continuous spectrum is given. The isobaric analog resonance in heavy nuclei is considered as a special case of a collective state. The accuracy of the approximate methods used to calculate the nucleon resonance widths is estimated by the method of strong coupling of channels. (auth)

24653 ANALOGUE STATES AND RESONANCES. Temmer, G. M. (Rutgers-The State Univ., New Brunswick, N. J.). pp 249-69 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

A review is given of recent experiment on isobaric analog resonances (IAR), especially near closed shells, with examples in ^{208}Pb and ^{118}Sn where high-resolution inelastic-scattering data are now available. The use of polarized beams in the study of IAR is discussed. Several extensions of resonance experiments into the region of deformed and transition nuclei have revealed interesting structural information, although the question of the deformation dependence of Coulomb displacement energies has not been answered as yet in view of complications. The use of (p,n) reactions with resolved neutron groups via IAR for nuclear spectroscopy seems promising. Many new results are available on gamma decay of IAR, especially for those with isospin-forbidden particle-decay channels, observed mainly in the p-shell and ds-shell nuclei. The question of the isobaric spin splitting of the giant dipole resonance (mainly in ^{90}Zr) is under active investigation. Useful connections have been pointed out between E1 decay of IAR and corresponding first-forbidden beta transitions. Another class of gamma transitions recently observed are those de-exciting residual excited states following inelastic proton scattering through IAR, shedding light on the particle-hole structure of excited states. The difference between "allowed" (conventional) and "forbidden" IAR is discussed, and the current situation for $T = \frac{1}{2}$ states in $T_z = -\frac{1}{2}$ nuclei is summarized in the light of recent successful analyses of these resonances to extract partial and total widths. The status of $T = 2$ states in $T_z = 0$ nuclei is presented. The role of T-allowed particle-transfer reactions in establishing the properties of these T-multiplets is emphasized. Finally, a number of open problems in these areas are presented, such as stripping to isospin-forbidden states, the use of neutrons in the study of IAR, and two — or more — particle transfer reactions in the heavy nuclei to excite additional members of T-multiplets. It is pointed out that the theoretical understanding of such problems as the widths of these T-forbidden IAR, or the structural Coulomb displacement energy shifts found between multiplet members, is generally still lacking, although precise experimental values, and the ingredients for calculations, are available. (auth)

24654 FINE STRUCTURE AND QUASIBOUND STATES. Gillet, V. (CEN de Saclay, Gif-sur-Yvette, France). pp 271-82 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

With the exception of single-particle resonances, or of the gross structure of the giant resonance, the nature of unbound nuclear states is still largely unexplored. However, this field of research is becoming rapidly a most promising one. This is due on one hand to the extension of shell model concepts and techniques to the microscopic description of nuclear modes above particle emission threshold, and on the other hand to the recent development of the technology of cluster transfer reactions (i.e., reactions where a number of nucleons are added to a target nucleus). The fine structure of nuclear continuum states is interpreted in the framework of the shell model as the result of coupling unbound configurations to many particle–many hole quasibound states. The density of the resonances is linked to the density of shell model quasibound states which can be formed while the widths of the peaks are related to the overlap between the wave-functions of the quasibound states and of the unbound configurational states. This description is amenable to experimental verification. For example an interference shape in the cross-section curve for a process induced by a one body operator may be attributed to a n particle–n hole quasibound state when a resonance in the excitation cross-section via the transfer of a n-p cluster to a n-h target occurs at the same energy. As an illustration the present experimental situation for the ^{16}O continuum is reviewed. (auth)

24655 THE STUDY OF ATOMIC NUCLEI USING NEUTRON SPECTROSCOPY METHODS: SOME RESULTS AND PROSPECTS. Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 283-97 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The results of some investigations performed recently on the pulsed reactor of the Laboratory of Neutron Physics, Dubna, are presented. The experiments on the (n,α) reaction in resonances with ^{143}Nd, ^{145}Nd, ^{147}Sm, ^{149}Sm, ^{95}Mo, and some others as targets are discussed in greatest detail. The results of measuring variations of the neutron average number ν per fission event in neutron resonances of ^{239}Pu and ^{235}U are presented; these experiments yield information on the dependence of ν on the spin of a fissionable nucleus. The gamma-spectra study of neutron radiative capture in resonances and also the future prospects of applying polarized neutrons and oriented nuclear targets in neutron spectroscopy are given briefly. (auth)

24656 SIMPLE NUCLEAR EXCITATIONS DISTRIBUTED AMONG CLOSELY SPACED LEVELS. Axel, P. (Univ. of Illinois, Urbana). pp 299-316 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

A review is given of the limited information available about the correct description of simple nuclear excitations when they are mixed with more complicated excitations to form the quasi-stationary highly excited states of nuclei. Examples are given which illustrate the energy region over which a simple excitation appears, the existence of local variations or intermediate structure with a characteristic energy of about 100 keV, and correlation which might exist between two different simple excitations. The types of simple excitations considered are single-particle states, analog states, and electric dipole excitation. There is little quantitative information about the gross spreading of single-particle strength despite the successess of the optical model and the popularity of transfer reactions. There may be some evidence for intermediate structure in reported variations of neutron scattering cross-sections, but the interpretation is ambiguous. A convincing and educational example of a single-particle "doorway" is given by the Monahan and Elwyn analysis of s-wave neutron resonances in Fe. The fragmentation of an analog state among the $T_<$ states is another interesting example of experimentally observable spreading of strength. Additional information on the spreading of strength in highly excited states (e.g., in ^{90}Y) can be obtained by studying the more easily seen corresponding analogues (e.g., in ^{90}Zr). Information on the spreading of electric dipole strength can be obtained directly from gamma-ray interaction cross-sections. The non-statistical neutrons emitted from the giant dipole resonance provide guidance for the theoretical description of the resonance. At energies well below the giant resonance there is evidence for substantial intermediate structure. In the same energy region comparisons between (γ,γ) and (γ,p_0) cross-sections are particularly sensitive to correlations. Many more relevant experiments will be needed before the spreading of strength and the correlations between different simple excitations are understood. (auth)

24657 RADIATIVE TRANSITIONS FROM HIGHLY EXCITED NUCLEAR STATES. Bollinger, L. M. (Argonne National Lab., Ill.). pp 317-47 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The experimental characteristics of radiative transitions from the highly excited states formed by slow-neutron capture are summarized. The partial radiation widths obtained from the refined spectra measured with Ge-diode γ-ray spectrometers are in good agreement with the Porter–Thomas distribution. Both the absolute values and the energy dependence of the widths for E1 transitions are in quantitative agreement with what is expected from the presence of the electric-dipole giant resonance at a higher energy. Various kinds of nuclear-structure effects for E1 radiation are examined critically. For relatively light nuclides there is convincing evidence for a correlation between the strengths for (n,γ) and (d,p) transitions, as is expected if the single-particle component of radiative capture is significant. For the typical heavy nucleus, recent measurements show that the radiation width is independent of the character of the final state to a high degree of refinement. However, two experiments seem to indicate that single-particle effects are significant in the reaction

$^{169}Tm(n,\gamma)^{170}Tm$, since they give convincing evidence for a correlation between radiation and neutron widths. However, the expected correlation between (n,γ) and (d,p) strengths for this reaction are not observed. Evidence concerning hard-sphere capture is described. The reduced widths for M1 transitions are summarized. They are found to be considerably larger than expected. Also, there is some indication that the reduced widths for ^{136}Ba and perhaps some tin isotopes are abnormally large. The reduced widths for M1 transitions in ^{136}Ba exhibit a strong energy dependence. (auth)

24658 DENSITIES OF NUCLEAR LEVELS AND STRENGTH FUNCTIONS AT EXCITATION NEAR THE NEUTRON BINDING ENERGY. Pikelner, L. B. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 349-64 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

A review is given of some recent work on neutron spectroscopy of non-fissionable nuclei. Neutron transmission and radiative capture were measured for separated isotopes of rare earths, neodymium, gadolinium and erbium, and for isotopes of germanium and selenium. Parameters of the considerable number of levels of these isotopes were obtained, by which strength functions, average level spacings, single-particle state density near the Fermi energy were calculated. Strength functions of rare earths have a weak maximum at $A \simeq 160$, in addition to two main peaks at $A \simeq 145$ and $A \simeq 180$ associated with nuclear deformation in this mass number region. Strength functions of germanium and selenium isotopes are in satisfactory agreement with the calculations from the optical model, which take into account nuclear dynamic deformation. The detailed experimental data on nuclear level density in the rare earth region made it possible to determine reliably a peak of the density g of single-particle states near the Fermi level at $A \simeq 150$. As was shown by the calculations of Furman and Popov, the experimental results are in satisfactory agreement with theoretical $g_{shell}(N)$ calculated from single-particle level schemes in the deformed well. Level spacings versus neutron excess in a nucleus (N−Z) in the region of light nuclei are discussed and comparison is made with the experimental data. (auth)

24659 HYPERFINE MAGNETIC FIELDS ON MOVING ATOMS IN FERROMAGNETIC MEDIA. Grodzins, L. (Massachusetts Inst. of Tech., Cambridge); Winther, A. pp 395-401 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Strong transient magnetic fields have been shown to act on moving ions during slowing down in ferromagnetic materials. A summary of the experimental evidence is given together with a short description of a theoretical model. (auth)

24660 NUCLEAR COLLECTIVE HAMILTONIAN AND DEFORMATIONS. Kumar, Krishna (Univ. of Copenhagen). pp 419-30 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The scope and limitations of a recently developed treatment of collective quadrupole motion of even-even nuclei are reviewed. This method is based on Bohr's collective Hamiltonian and the pairing-plus-quadrupole model. With an exact, numerical treatment of the couplings between the five components of quadrupole motion, the theory is able to explain and predict many trends in the low-lying levels and electromagnetic moments of nuclei in the W−Os−Pt region. The zero-point quantal motion plays an important role in spreading the nuclear wave-function in the β-γ plane so that the nucleus is affected essentially by the behavior of the collective Hamiltonian away from the equilibrium shape. The γ-dependence of the Hamiltonian, especially the prolate-oblate difference term of the potential function, plays a crucial role in the splitting of the $2'^{+}$ and 4^{+} states and the non-zero quadrupole moments of $I \neq 0$ states, which can occur even if the equilibrium shape is spherical or completely asymmetric with $\gamma = 30°$. The anharmonicities of the six inertial functions of Bohr's Hamiltonian cause $\beta-\gamma$ band-mixing in the W isotopes, reduce the ground-β-γ band-mixing in the Os isotopes, and counteract the prolate-oblate difference term so that the spectrum of the calculated ^{196}Pt appears to be vibrational. The calculation for ^{196}Pt gives a large, oblate quadrupole moment of the first 2^{+} state as well as a small cross-over transition from the ground state in the second 2^{+} state. However, the calculated $2'^{+}$ states of $^{192-196}Pt$ are too high by 0.1-0.2 MeV, and the calculated $B(E2; 2 \rightarrow 2')$ values for the region are too large by about a factor of two. Some possible ways of improvement are indicated. (auth)

24661 INTERMEDIATE STATES IN FISSION. Strutinskii, V. M.; Bjoernholm, S. (Univ. of Copenhagen). pp 431-48 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Consequences of the presence of a second, intermediate equilibrium state at large deformations in some fissioning nuclei (two-humped fission barrier) are discussed. The most important effects related to such states are: (1) spontaneously fissioning isomers, (2) grouping of neutron-induced fission resonances, related to intrinsic states in the second potential well, (3) vibration-mode resonances in the fission cross section, and (4) moderation of the channel structure in fission fragment anisotropies for fission near the barrier. An attempt is made to summarize the evidence obtained from various experiments. (auth)

24662 STRUCTURE EFFECTS IN NUCLEAR FISSION. Lynn, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 463-88 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Two kinds of structure in sub-threshold fission were observed and are reviewed here. The first kind, called gross structure, are the peaks ranging over some tens of keV in width in the neutron cross sections, averaged over energy intervals that include very many fine-structure resonances, for fission of many actinide nuclei. The second kind, called narrow intermediate structure, is spectacular, and is found in narrow groups of fine-structure resonances with anomalously high fission widths. The explanation for both these kinds of structure seems to be the Strutinsky potential energy curve for the prolate deformation of transuranic nuclei. This exhibits a secondary minimum before reaching the saddle-point. This secondary minimum, in which the compound nucleus has a low effective excitation energy, may be responsible for the weak-mixing of fission modes into the compound nucleus motion (gross structure), as well as for the appearance of a second class of "compound nucleus states," with large fission widths, that are only very weakly coupled to the much denser "normal" class of compound nucleus states (narrow intermediate structure). (auth)

24663 FISSION OF EXCITED NUCLEI. Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 489-99 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Nuclear fission at excitation energy more than 50 MeV was investigated. It is shown that the statistical theory determines a nuclear state at the saddle-point rather well, but appears to be inapplicable for describing the process at the scission point. This conclusion is based on the experiments on mass and charge distributions of fission fragments for nuclei in the wide Z^2/A range. (auth)

24664 STUDIES ON THE CHANGES OF NUCLEAR CHARGE RADII USING THE EFFECT OF X-RAY LINE ISOTOPE SHIFT. Sumbaev, O. I. (Ioffe Inst. of Physics and Tech., Leningrad). pp 527-39 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The effect of the X-ray volume isotope shift in ordinary atoms is discussed as a new experimental method for determining the differences between the nuclear charge radii ($\Delta\langle r^2\rangle$) of isotopes. The core of the subject, which deals with the possibility of sufficiently accurate ($\lesssim 5\%$) transition from the measured ΔE shifts to $\Delta\langle r^2\rangle$ for the nuclei of the isotopes compared, is described. A summary of the experimental data, obtained by using the method considered, is presented. It is evident from these data that the experimental errors can be at present reduced down to a few percent from the value of the shift, i.e., they do not exceed the errors due to the transition from ΔE to $\Delta\langle r^2\rangle$ ($\lesssim 5\%$). The comparison of the values of $\Delta\langle r^2\rangle$ obtained by the X-ray I.S. methods for ordinary and mu-mesic atoms and by the optical I.S. method reveals satisfactory agreement. However, the X-ray data on the absolute values of $\Delta\langle r^2\rangle$ are considerably more accurate and reliable than the optical shift data. A comparison is made of the experimental results and the data calculated within the framework of Migdal's finite Fermi-systems theory. In conclusion, the new experimental data on $\Delta\langle r^2\rangle$ for Ba isotopes, which conform the presence of anomalies, similar to the known case $^{40-48}Ca$, are discussed. (auth)

24665 THE METHOD OF QUASIPARTICLES IN THE THEORY OF THE NUCLEUS. Migdal, A. (Inst. of Atomic Energy, Mos-

cow). pp 541-8 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The results of the application of Green's function to the theory of the nucleus are analyzed. It is shown that the large number of observed phenomena (quadrupole and magnetic moments, probabilities and transition rates, isotopic shifts, etc.) can be expressed by some constants identical for all medium and heavy nuclei. (auth)

24666 EFFECTIVE FORCE FOR NUCLEAR RANDOM PHASE APPROXIMATION (RPA). Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 549-62 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The theoretical evaluation of the effective force operators for nuclear structure models is achieved within different approximate schemes. Some of the matrix elements of the force result from the study of the association energies of nucleons, which involves various assumptions of nuclear coupling. Further information on the effective force is obtained by solving equations for the reaction-matrix—a reliable operator substituting the realistic inter-nucleon force—and also from the data available on the nuclear-matter properties. When comparing this information with "experiment" it should be remembered that each of the models is characterized by its own effective force evaluated from appropriate equations. Much attention is given to the precise definition of the effective force for a particular model, the random phase approximation (RPA), and the relationship is established between the effective force operator and the reaction-matrix, on the one hand, and the scattering amplitude in the Fermi-liquid theory, on the other. Some estimates for the zero-range effective force are given. These are obtained from the data on the density dependence of the local part of the nuclear self-consistent potential. The resulting operator depends on the density itself. (auth)

24667 EFFECTIVE NUCLEAR FORCES. Brown, G. E. (State Univ. of New York, Stony Brook). pp 563-76 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

Calculation of effective forces in nuclei from the Hamada-Johnston potential is described. This work begins from the theories of Brueckner and Bethe and applies them to finite systems. Various renormalizations of the force are discussed. The density dependence of the effective forces is considered in detail. Arguments for the partial breakdown of the shell model in heavy nuclei are given. (auth)

24668 GENERAL NUCLEAR PROPERTIES WITH EFFECTIVE INTERACTIONS. Moszkowski, S. A. (Univ. of California, Los Angeles). pp 577-89 of Nuclear Structure: Dubna Symposium, 1968. Vienna; International Atomic Energy Agency (1968).

From International Symposium on Nuclear Structure, Dubna, USSR. See STI/PUB-189; CONF-680702.

The use of some effective interactions in calculating properties of closed shell nuclei and of the nuclear surface is described. Closed shell nuclei have been investigated by several groups; the work of three of these groups is discussed here. Davies, Baranger et al., use a momentum-dependent Gaussian effective interaction whose parameters are adjusted to fit the binding energy and density of nuclear matter using first-order perturbation theory and also match at least the low-energy nucleon-nucleon scattering phase shifts. Pearson and Saunier use quite similar interactions except that instead of fitting low-energy scattering data, they insist that the long range part must be of the one-boson exchange form, at least in $^1S_0$ states. Brink and Boeker study various interactions which fit nuclear matter and the alpha particle binding energy. For ^{16}O, these groups obtain somewhat too low a binding energy. Bethe has worked out a theory of the nuclear surface, which uses a quite simple effective interaction derived from a realistic interaction. Bethe uses the Thomas-Fermi approximation and obtains an analytic form for the particle density distribution at the nuclear surface. He also calculates the nuclear surface energy and surface thickness and obtains good agreement with empirical values. The nuclear surface problem has also been studied by other authors who do not make the Thomas-Fermi approximation. In particular, if one uses a simple effective interaction of the form suggested by Skyrme, with the same criteria as Brink and Boeker, then the surface energy comes out in good agreement with empirical values. In addition, this effective interaction can be used to assess the accuracy of the Thomas-Fermi approximation. This approximation underestimates the surface energy by only $1\frac{1}{2}$ MeV. (auth)

For abstracts of individual lectures see: 24262, 24405, and 24670-24679.

24669 NUCLEAR PHYSICS. DeWitt, C.; Gillet, V. (eds.). Universite de Grenoble Ecole d'ete de Physique Theorique Les Houches, 1968. New York; Gordon and Breach Science Publishers (1969). 815p.

Recent developments in theoretical nuclear physics, dealing especially with the microscopic description of nuclear structure, high energy linear accelerators, variable energy cyclotrons, etc., are discussed. Twelve lectures, each of which is abstracted individually, are contained. (L.W.A.)

24670 NUCLEAR FORCES, NUCLEAR MATTER AND FINITE NUCLEI. Moszkowski, S. (Univ. of California, Los Angeles). pp 1-149 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

Nucleon-nucleon interactions, which may be used to calculate nuclear structure properties, are discussed in terms of nucleon-nucleon scatterings and in terms of interactions which reproduce the binding energy and density of the nuclear matter. Calculations of the ^{16}O ground state using interactions with various degrees of realism are mentioned in terms of their value as a test of the interaction. The empirical evidence and the theoretical derivation of nuclear surface properties—surface energy, surface thickness, and neutron and proton density distribution at the surface—are discussed in terms of simple nucleon-nucleon interactions. (133 references). (L.W.A.)

24671 MANY-BODY THEORY FOR NUCLEAR PHYSICISTS. Baranger, M. (Carnegie-Mellon Univ., Pittsburgh). pp 151-204 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

Applications of Feynman diagrams, second quantization, and Wick's theorem are discussed. Wick's theorem and its equivalence with Feynman diagrams are proved. (L.W.A.)

24672 REALISTIC TWO-BODY FORCES IN NUCLEAR STRUCTURE PROBLEMS. Wong, Chun Wa (Univ. of California, Los Angeles). pp 205-39 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

A qualitative and elementary description of the treatment of the nuclear structure problem via perturbation theory is presented. The discussion emphasizes the simplification of the perturbative treatment of nuclear structure problems through the knowledge of nuclear forces. An argument showing the perturbative approach is meaningful only if nuclear forces are rather weak is presented. The solution of the reaction matrix equation is considered briefly, and the use of the Pauli operator with respect to a particular choice of the shell-model space is emphasized. (L.W.A.)

24673 SELECTED TOPICS IN NUCLEAR DEFORMATIONS. I. MOMENTS OF INERTIA, QUADRUPOLE POLARISATIONS, AND 2 PARTICLE-2 HOLE EXCITATIONS IN EVEN-EVEN N = Z NUCLEI. Ripka, Georges (Centre d'Etudes Nucleaires, Saclay, France). pp 241-74 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

Some results and problems encountered in the microscopic description of the spectra of 2s-1d shell nuclei which have equal numbers of neutrons and protons are discussed. The independent particle model of these intrinsic states and the Hartree-Fock calculations of the deformed field are reviewed. The method by which the polarization of closed shell renormalizes single particle operators and the effective two-body interaction is discussed, as is the effect of the polarizations on the moments of inertia of the deformed intrinsic states. Also, the admixtures of 2 particle-2 hole to the intrinsic states and the difficulties encountered in attempting to use B.C.S. wavefunctions in even-even N = Z nuclei are presented. (L.W.A.)

24674 SELECTED TOPICS IN NUCLEAR DEFORMATIONS. II. NUCLEAR ROTATIONS IN THE STRETCH SCHEME. Gillet, Vincent (Centre d'Etudes Nucleaires, Saclay, France). pp 275-302 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

The stretch scheme, as a useful tool to understand rotational nuclei in terms of the residual two-body force, is discussed. A classical analog, which depicts the way in which nucleon-nucleon forces induce rotations in the stretch scheme, and a calculation of the stretch spectrum with Raynal's method are presented. Characteristics of the stretch scheme spectrum and the stretch excited states in spherical nuclei are discussed. A comparison is made between the stretch ground state and the state of seniority, and the overlap between paired and ground states is discussed. (L.W.A.)

24675 STATISTICAL NUCLEAR THEORY. Bloch, Claude (Centre d'Etudes Nucleaires, Saclay, France). pp 303-411 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

A discussion of the shell model and the model of the completely random Hamiltonian is presented. Statistical problems related to the effective separation of giant or intermediate resonance from an experimentally observed fluctuating cross-section are discussed. Methods developed through the use of the similarity of these statistical problems with the problems of communication theory are shown to be applicable to the statistical theory of nuclear reactions. (L.W.A.)

24676 NUCLEAR CONTINUUM STATES, AND ISOBARIC ANALOG RESONANCES. Weidenmueller, H. A. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 413-504 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

The full nuclear Hamiltonian model is used to discuss the shell-model approach to nuclear reactions. Potential scattering is reviewed, and the calculation of nucleon-induced reactions in the light nuclei is presented. A definition of the full nuclear Hamiltonian model, along with a discussion of its advantages and shortcomings and its physical contents, is presented. The basic equations which govern later developments are derived, and an application of the methods due to Feshbach and MacDonald to the model is discussed. The coupled channels approach, an approximation scheme used to calculate nucleon-induced reactions on the light nuclei, is treated, and the theory of the isobaric analog resonances is developed. (116 references). (L.W.A.)

24677 THEORY OF THREE-PARTICLE SYSTEMS APPLICATION TO THE MANY-BODY THEORY OF NUCLEAR REACTIONS. Brezin, E. (Centre d'Etudes Nucleaires, Saclay, France). pp 505-41 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

Scattering for multichannel processes is briefly discussed, and an examination of the inadequacies of the Lippmann–Schwinger integral equation for the solution of the three-particle Schroedinger equation with definite boundary conditions is presented. L. D. Faddeev's solution for the three-particle system is examined, and the angular momentum analysis is performed in order to view the equations. The Bloch–Gillet method is summarized, and a generalization of Faddeev's equations for a many-body system is presented. (L.W.A.)

24678 SHORT RANGE CORRELATIONS. Danos, Michael (National Bureau of Standards, Washington D. C.). pp 543-84 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

Strong short range two-body correlations are assumed to exist in nuclei, and the consequences of this assumption are explored. (L.W.A.)

24679 SELECTED TOPICS ON THE INTERACTION OF MUONS AND PIONS WITH NUCLEI. Rho, Mannque (Centre d'Etudes Nucleaires, Saclay, France). pp 669-99 of Nuclear Physics. /DeWitt, C. (ed.). New York; Gordon and Breach Science Publishers (1969).

The use of muons and pions as a probe for nuclear structure is discussed. Mu- and pi-mesic atoms, the theory of muon and pion capture in nuclei, the application of muon capture as a test of nuclear wave functions, and radiative pion absorption are discussed. (47 references). (L.W.A.)

24680 AXIAL-VECTOR SUM RULES FOR ^{3}He. Walsh, Thomas F.; Peterson, Earl A. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1764. Phys. Rev., D; 1: 274-8(1 Jan 1970).

Two sum rules for the axial-vector form factor for the ^{3}He–^{3}H isodoublet are presented and discussed, the conventional Weisberger–Adler sum rule, and a new plane-wave sum rule. Both sum rules are well satisfied. A method of improving the impulse-approximation estimate of pion-cross-section differences is presented, and the various disintegration cuts and anomalous thresholds inherent in a nuclear dispersion relation are discussed. (auth)

24681 PERTURBATION THEORY OF NUCLEAR SCATTERING INCLUDING RECOIL. Redish, Edward F. (Massachusetts Inst. of Tech., Cambridge. Univ. of Maryland, College Park); Villars, Felix. Ann. Phys. (N. Y.); 56: 355-90(Feb 1970).

The theory of elastic nucleon–nucleus scattering is generalized to include the recoil of the nucleus. The exact T matrix is obtained as the residue of a second-order pole of an off-diagonal single particle Green function. A perturbation expansion is made using the intrinsic Hamiltonian and a new generalization of the Goldstone expansion for the ground state. This makes the extraction of the delta function for overall momentum conservation simple. A linked cluster expansion is derived for the Green function and two types of recoil corrections are identified, linked and unlinked. A new theorem is proved, expressing the exponent of a one body operator in a convenient way. It can then be shown that terms with linked corrections cannot contribute to the scattering. The T matrix including recoil is then expressed as the T matrix of the generalized optical potential calculated in the usual way (but using the intrinsic Hamiltonian) multiplied by a correction factor due to recoil. An approximation scheme for calculating the correction factor is presented and suggestions are made for improving existing calculations. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 22858, 22972, and 24876.

24682 NUCLEX 69: 2nd INTERNATIONAL FAIR AND TECHNICAL MEETINGS FOR NUCLEAR INDUSTRIES, BASEL, SWITZERLAND, OCTOBER 6–11, 1969. Basel; NUCLEX 69 (1970). 780p. (In several languages). (CONF-691018).

Included are 76 papers on the development and use of nuclear power plants, radiation sources, and radioisotopes. A separate abstract was prepared for each of 74 papers. Two papers were previously abstracted for NSA and can be located under CONF-691018 in the report number index. (H.D.R.)

For abstracts of individual papers see: 22687, 22865, 22895–22907, 24485, 24683–24701, 24724–24729, 24776–24778, 24780, 24787–24798, 24816, 24823, 24824, 24839–24841, 24849–24857, 24865, and 24866.

24683 CONSTRUCTION AND DEVELOPMENT OF ELECTRICITE DE FRANCE NUCLEAR POWER STATIONS. Leo, B. (Electricite de France, Paris). Technical Meeting No. 1/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

The development of graphite-gas central station nuclear power plants by Electricite de France is reviewed. The first 3 units at Chinon are described, and the design and operational parameters of the Saint Laurent-des-Eaux plant are examined. The fabrication and erection of the Bugey I reactor prestressed concrete vessel, thermal insulation of the vessel, and advantages and disadvantages of gas cooling are discussed. Application of EDF experience to the construction of the Vandellos plant is described. (H.D.R.)

24684 EXPERIENCES IN CONSTRUCTION OF THE BEZNAU NUCLEAR POWER PLANT. Veya, R. (Nordostschweizerische Kraftwerke AG, Beznau, Ger.). Technical Meeting No. 1/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

The functional principle and layout of the double containment of the Beznau nuclear power plant is described. The positive aspects and the particularities of the lifting-jack construction method for the steel container are discussed. Experiences in applying the ASME-Codes and in performing the pressure and leak rate tests are presented. (auth)

24685 HIGH TEMPERATURE GAS-COOLED REACTOR SYSTEMS. Rickard, C. L. (Gulf General Atomic, Inc., San Diego, Calif.); Fischer, P. U. Technical Meeting No. 3/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The 40-MW(e) prototype HTGR power plant at the Peach Bottom Atomic Power Station has successfully demonstrated the main features of the concept. Based on the same fundamental principles, plus some thoroughly tested new components, the 330-MW(e) HTGR Fort St. Vrain Nuclear Generation Station is being constructed with commercial operation scheduled for early 1972. Design and development work is now proceeding rapidly for HTGRs in the 600 to 1100-MW(e) range. (auth)

24686 HIGH TEMPERATURE REACTORS WITH HELIUM TURBINES: FROM THE 22 MW(e) NUCLEAR POWER PLANT (KWSH) TO HELIUM TURBINE NUCLEAR POWER PLANTS OF GREATER POWER. Boehm, E. (Gutehoffnugshuette Sterkrade AG, Oberhausen, Ger.); Bammert, K. Technical Meeting No. 3/10 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

The adoption of the He cooled high-temperature reactor in the closed gas turbine circuit has the following advantages: it is highly efficient; it simplifies and reduces the plant; and it substitutes a small He turbo set for the comparatively large steam turbine. As part of the Third German Atomic Energy Programme, GHH is erecting a 22 MW(e)-nuclear power plant with high-temperature reactor and He turbine, scheduled to go into operation in 1973 at Geesthacht/Schleswig-Holstein. To develop this type of nuclear power station still further, several helium test facilities will be set up and design work is carried out for a 600 MW(e)-nuclear plant. (auth)

24687 EXPERIENCE OF CONCRETE PRESSURE VESSELS IN RELATION TO REACTOR SAFETY. Burrow, R. E. D. (Taylor Woodrow Construction Ltd., Southall, Eng.); Hay, J. D.; Williams, A. J. Technical Meeting No. 5/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Some of the principles adopted in the design and construction of the Oldbury and Wylfa pre-stressed concrete pressure vessels are described, and the experience gained during commissioning and operation is examined. (auth)

24688 QUALITY ASSURANCE AND THE SITE ASSEMBLED NUCLEAR REACTOR PRESSURE VESSEL. Webb, R. S. (Chicago Bridge and Iron Co.). Technical Meeting No. 5/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The effects of site assembly of pressure vessels on nuclear power plant siting requirements are examined. Quality assurance aspects for this type of construction are discussed, and the importance of proper handling of the quality assurance program is emphasized. The results of the projects for site assembly of the Monticello and Vermont Yankee vessels are described. (H.D.R.)

24689 CONTROL, MANAGEMENT, AND AUTOMATION OF THE BOILING WATER REACTOR. Crowther, R. L.; Holland, L. K. Technical Meeting No. 6/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The inherent nuclear and control characteristics of the BWR have led to a gradual evolution of automation features that has been brought about by trends to improve performance and economics, rather than control system requirements to provide stable operation. Control and instrumentation system automation has been selective and based on a sub-system as opposed to overall system approach. The on-line computer is assuming an increasing role in BWR control and instrumentation. It is being used to provide more accurate interpretation of in-core ion chamber measurements and aids the operator in making better decisions. Primary emphasis on near term future developments of the on-line computer are directed toward improving operations management and optimization of fuel cycle performance. The evolution of BWR automation and future expected trends are summarized. (auth)

24690 DIGITAL COMPUTER APPLICATION TO ADVANCED GAS-COOLED REACTOR SYSTEMS. Makin, J. E.; Shirra, J. M. Technical Meeting No. 6/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018

The English Electric type 2140 processor system applied to the advanced gas-cooled reactor power station at Hinkley Point B is described. (auth)

24691 THE POSSIBILITY OF AUTOMATION IN THE CONTROL OF NUCLEAR POWER PLANTS. Panis, L. M. Technical Meeting No. 6/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

A well-proven, reliable solid-state system for the automation of turbine-generators and complete power stations, using fixed wired logic elements, is described. If used in conjunction with a digital computer supplied for data processing, the computer could additionally take over subordinate reactor controls or even the overall control of the power station. (auth)

24692 PROSPECTS FOR COMPUTER CONTROL IN NUCLEAR POWER PLANTS. Smith, J. E.; Morris, D. I. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Technical Meeting No. 6/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The performance of a single digital control computer in a 220

MW(e) nuclear station is discussed. This computer has been in operation for almost five years. The experience with this computer influenced the design of the next system of eight control computers in a 2200 MW(e) nuclear station. The two systems are compared for capacity, speed, and cost. The reasons for the relatively low cost of the eight computer system are given. Redundancy as a method of obtaining the requisite reliability is discussed and the design consequences of choosing a twin computer controller are described. (auth)

24693 AUTOMATION IN THE CONTROL AND REGULATION OF NUCLEAR POWER STATIONS. Dive (Electricite de France, Paris); di Giacomo; Bobigeat; Peinturier; Woillez; Authier; Bonnemort; Escalona; Moinereau. Technical Meeting No. 6/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

French developments in the field of control systems for nuclear power plants are reviewed and operational experience with various systems is examined. Separate sections discuss: (1) control systems on operating French power stations; (2) automation through use of a central computer and associated automated units; (3) design, operation, and development potential of the EL-4 reactor modular static relaying system; (4) computer control of pressurized water reactors; and (5) computer control of French gas-graphite reactors. (H.D.R.)

24694 ON-LINE COMPUTER APPLICATION TO A PWR NUCLEAR POWER PLANT. Bevilacqua, F.; Yuile, E. A. Technical Meeting No. 6/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The application of real time digital process computers to a typical C-E nuclear steam supply system is described. Basic functions of the computers for this application are plant surveillance, assimilation of plant data, on-line calculation of reactor and secondary plant performance, on-line processing of in-core data, secondary plant performance, and supervisory control of control rod positions. The computer for a typical PWR plant allows 600 to 1100 analog inputs, 400 to 600 digital inputs, and 12 to 24 interrupts. (auth)

24695 ANOTHER STEP FORWARD IN THE GENERAL ELECTRIC BOILING WATER REACTOR DESIGN. Clancey, W. R.; Hogle, J. J.; Kjemtrup, J. E. Technical Meeting No. 9/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Some technical innovations that enhance the safety and simplicity and at the same time improve the performance and decrease the cost of the BWR plant are described. The particular product improvements involve the main recirculation loop, the emergency core cooling systems, the steam bypass system and the design of the containment structure. Optimization of the recirculation system results in a more compact loop that utilizes a throttling valve to vary the amount of recirculation flow which in turn controls the power level. Engineering studies of the emergency core coolant systems resulted in combining the functions of two separate systems for different pressure ranges into one system that covers all pressure conditions, and re-routing the core flooding system directly to the pressure vessel instead of into the recirculation loop. To permit the reactor to sustain the infrequent rejection of full load without scram, an improved relief valve system blowing down to the suppression pool is used to save the expense of a full turbine steam bypass system. Considerable economics can be achieved by use of a cone-shaped primary containment structure with the suppression pool occupying the base of the cone. This type of containment is ideally suited to concrete construction. (auth)

24696 THE ASEA–ATOM BOILING WATER REACTOR. Tenerz, E.; Widell, B. (ASEA–ATOM, Vasteras, Sweden). Technical Meeting No. 9/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

A presentation of AB ASEA-ATOM's BWR is given with special reference to the background of the design philosophy. The theoretical and experimental results from the last five years' development work are discussed from the point of view of fuel and core layout. The development has been extensive and the present design is more advanced than that for the first reactor. This can be seen from the increased power density and burnup as well as the reduced thicknesses of cladding and boxes. (auth)

24697 DESIGN, DEVELOPMENT, AND CONSTRUCTION OF THE BUGEY 1 GRAPHITE SUPPORT GRID. Chevallier, R. (Societe Alsthom, Paris); Andreani, A.; Perona, M. Technical Meeting No. 9/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

The graphite support grid, the design and operational behaviour of which govern the mechanical stability of the core and the maintenance of its geometrical characteristics, is one of the essential structural components of the reactor. The choice which had to be made between various possible solutions in the course of the design study is discussed. Then the various parts of the support grid are described. Finally the significant steps in the construction of the grid are listed. (auth)

24698 ADVANCES IN CURRENT GAS-COOLED REACTOR DESIGNS IN THE UNITED KINGDOM. Lowthian, C. S.; Tyrrell, J. F. Technical Meeting No. 9/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Some of the new design features which are being introduced into the gas-cooled reactors now being built in the U. K. are described. They include the encapsulated circulator, $Ca(OH)_2$ and steel boiler shield wall, and ceramic fibre insulation design at Hinkley B, together with the pod boiler vessel style, boilers and refuelling machine at Hartlepool. (auth)

24699 STATUS AND TRENDS OF THE WESTINGHOUSE PRESSURIZED WATER REACTOR. McGrath, R. G. Technical Meeting No. 9/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The nuclear steam supply systems for operating units are quite similar which indicates that the status of the Westinghouse PWR is one of maturity. The future is to improve the concept even more by adding improvements and refinements and incorporating data feedback from operating plants. (auth)

24700 NEW DESIGN FEATURES FOR LARGE PWR. Abbott, W. E. Technical Meeting No. 9/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Numerous improvements during pressurized water reactor development have resulted in significant differences between PWR's offered by various manufacturers. The special design features offered by Combustion Engineering are described. Each feature is appraised with respect to costs, availability, and reliability. (auth)

24701 DESIGN AND SAFETY ENGINEERING ASPECTS FOR THE PRIMARY COOLING SYSTEM OF LARGE PRESSURIZED WATER REACTORS. Ruf, R. (Siemens AG, Munich). Technical Meeting No. 9/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

The first Siemens light water reactor of 300 MW(e) has been in operation since March 1969. The next plant of the same type but with 630 MW(e) will be finished at the beginning of 1972. In 1974, the nuclear power plant Biblis with 1200 MW(e) will be operating. Problems associated with increased power are discussed, especially with respect to the primary cooling circuit and the pressure vessel. Construction of the components, computer programs for safety evaluation, and methods for nondestructive testing are discussed. (H.B.G.)

24702 GERMAN NUCLEAR POWER PLANT PROJECTS. Atomwirt., Atomtech.; 15: 166-8(Apr 1970). (In German).

Some of the design characteristics, principal contractors, and scheduling are tabulated and discussed for planned nuclear power plants. The projects described include: Brunsbuettel; KBE-1; Mannheim-Nord; Gemeinschaftskernkraftwerk Neckar (GKN); BASF-Industriekernkraftwerk; Kernkraftwerk Bayern; THTR; SNR; KBE-2; and CWH/VEW Industriekernkraftwerk. (H.D.R.)

24703 NEW GERMAN NUCLEAR POWER PLANTS: WORKS IN PROGRESS. Atomwirt., Atomtech.; 15: 169-71(Apr 1970). (In German).

The construction status of the KNK, Niederaichbach (KKN); Schleswig-Holstein (KSH), Biblis (KKB), and Stade (KKS) power reactors are briefly summarized. (H.D.R.)

24704 NEW NUCLEAR POWER PLANTS IN EUROPE. Atomwirt., Atomtech.; 15: 176-85(Apr 1970). (In German).

Nuclear power plants in operation, under construction, and planned in Western Europe are described. Projects are included for Belgium, Finland, France, Great Britain, Italy, The Netherlands, Austria, Sweden, Switzerland, and Spain. (H.D.R.)

24705 IN-CORE INSTRUMENTATION AND ITS TASKS IN POWER REACTOR MONITORING. Sukrow, S. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernergie; 13: 1-6(Jan 1970). (In German).

In-Core instrumentation systems (activation systems, ionization chambers, neutron-sensitive thermocouples, Hilborn detectors, γ ray-sensitive thermocouples, semiconductor detectors, and in-core neutron flux monitoring channels) are described. Comparison of the instrumentation systems is presented. Processing of the measuring results is described. 22 references. (auth)

24706 PROSPECTS FOR 1970s OF THE DEVELOPMENT OF ATOMIC ENERGY. Tanaka, Yoshio (Science and Tech. Agency, Tokyo). Atomu; 15: 11-25(Jan 1970). (In Japanese).

The development of nuclear power generation is reviewed including: Europe, the United States, and Japan. The economics of nuclear power generation, including power cost; uranium resources, and the supply and resource development in the world is summarized. U enrichment, the amount of enriched U required, the enrichment effort in Japan, and spent fuel reprocessing, mainly in Japan are discussed. Enterprises associated with nuclear fuels are listed. Advanced thermal reactors and fast breeder reactors, their development in Japan and in other countries, multipurpose reactors for desalting sea water and process-heating, and nuclear powered ships, including the first ship in Japan, are also discussed. (NSA of Japan)

24707 DOMESTIC PRODUCTION OF LIGHT-WATER REACTOR POWER PLANTS: THE PRESENT STATE AND PROBLEMS. Toyoda, Masatoshi (Tokyo Electric Power Co., Inc.). Genshiryoku Kogyo; 16: No. 1, 38-41(Jan 1970). (In Japanese).

Electric power companies in Japan are proceeding actively with the construction of atomic power stations. Amid the tremendous growth of electric power demand, the power generation by atomic energy will be 8,000,000 kW in 1975, and 30,000,000 to 40,000,000 kW in 1985, and most reactors will be light-water type. The proportion of domestic products for atomic power plants has increased remarkably in recent years. In the case of No. 3 plant in the Fukushima Power Station, for instance, it is nearly 90%. For atomic power plants, a high degree of safety is required, therefore domestic manufacture should be carried out after the assurance in this respect. The present state of the domestic production of light-water reactors and the problems involved are described on the following: reactor core including fuel, control rods and driving mechanism, and core support; reactor pressure vessel; reactor containment vessel; coolant and steam circulation systems; fuel exchange; safety facilities; instrumentation and control; and radioactive waste treatment facilities. (NSA of Japan)

24708 AUTOMATIC CONTROL OF THE PWR POWER STATION. Okano, Shigeo (Kansai Electric Power Co., Osaka). Seigyo Kogaku; 13: 639-51(Oct 1969). (In Japanese).

The atomic power station in Mihama, Fukui Prefecture, is the first in Japan with a pressurized water reactor (PWR). In such power stations, the automatic control of operation is extensively employed. The control systems are multiple and safe against the failure of air and power sources. The automatic control of the PWR power station is described with the Mihama power station as an example. The outline of the Mihama PWR plant; the automatic control of the reactor, primary-coolant average temperature, steam dumping, feed water, primary-coolant pressure, chemical process, auxiliary cooling, waste disposal, safety injection, and turbo-generator, and the measures to protect the plant, including reactor tripping, are presented. (NSA of Japan)

24709 THE CONSTRUCTION DECISION FOR THE BRUNSBUETTEL NUCLEAR POWER PLANT. Tremba, E. (Hamburgische Electricitaets-Werke AG, Hamburg). Atomwirt., Atomtech.; 15: 189-90(Apr 1970). (In German).

The technical and economic factors and the projected demand for electric power that led to the decision to construct the 770 MW(e) Brunsbuettel boiling water reactor are briefly discussed. (H.D.R.)

Operation and Economics

24710 (DOCKET-1155-30) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, January 1970. (Dairyland Power Cooperative, La Crosse, Wis.). 24 Apr 1970. Contract AT(11-1)-851. 18p. Dep. CFSTI.

24711 (DOCKET-50016-34) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Operations Report, December 1969. (Power Reactor Development Co., Detroit, Mich.). 16 Apr 1970. 13p. (PRDC-EF-76). Dep. CFSTI.

24712 (DOCKET-50016-35) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Operations Report, January 1970. (Power Reactor Development Co., Detroit, Mich.). 16 Apr 1970. 12p. (PRDC-EF-77). Dep. CFSTI.

24713 (DOCKET-50029-115) YANKEE NUCLEAR POWER STATION. Operation Report No. 111, March 1970. (Yankee Atomic Electric Co., Westboro, Mass.). 21 Apr 1970. 7p. Dep. CFSTI.

24714 (DOCKET-50146-53) SAXTON REACTOR. Operating Experience Report, September 1, 1969-February 28, 1970. (Saxton Nuclear Experimental Corp., Pa.). 22 Apr 1970. 46p. Dep. CFSTI.

24715 (DOCKET-50171-47) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 48, February 1970. (Philadelphia Electric Co., Pa.). 16 Apr 1970. 11p. Dep. CFSTI.

24716 (DOCKET-50206-52) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, March 1970. (Southern California Edison Co., Los Angeles). Apr 1970. Contract AT(30-1)-3270. 6p. (NYO-3270-36). Dep. CFSTI.

24717 (DOCKET-50213-37) CONNECTICUT YANKEE ATOMIC POWER PLANT. More Than One Dropped Control Rod. Abnormal Occurrence Report No. 70-3. (Connecticut Yankee Atomic Power Co., Haddam). 13 Apr 1970. 2p. Dep. CFSTI.

24718 (DOCKET-50213-38) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 70-3, March 1970. (Connecticut Yankee Atomic Power Co., Haddam). 21 Apr 1970. Contract AT(30-1)-3250. 11p. (NYO-3250-46). Dep. CFSTI.

24719 (EUR-4395) ARDENNES NUCLEAR POWER PLANT. Annual Report, 1968. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-Lez-Givet (France)). Jan 1970. 28p. (In French). Dep. CFSTI (U. S. Sales Only). EUR FF 5,60.

After functioning satisfactorily for the last six months of 1967, the SENA nuclear power station was connected to the grid for only 18 days in 1968 owing to a turbine blading failure, followed immediately by the discovery of serious defects involving the reactor internals. Defects were also found in the primary pumps and the tube sheets of two out of the four steam generators. After a thorough investigation the work of repairing the various defective items of equipment was begun, but by the end of 1968 most of the repairs were not yet complete. Advantage was taken of the shutdown to carry out the necessary modifications to the turbine and main generator. The earliest date by which the station could be back in normal operation would appear to be about the end of 1969. At the end of 1968 the nuclear fuel in store consisted of nine spare elements and 40 elements for the fourth core charge. (auth)

24720 (SNE-53) THE PRODUCTION OF ^{238}Pu IN COMMERCIAL LIGHT WATER REACTORS. Roach, Kenneth E.; Turner, Stanley E.; Maxwell, William A. (Southern Nuclear Engineering, Inc., Dunedin, Fla. Southern Nuclear Engineering, Inc., Bethesda, Md.). Dec. 1969. Contract AT(29-2)-2741. 109p. Dep. CFSTI.

The production of ^{238}Pu from ^{237}Np target cans in pressurized-water reactors is described. The method described consists of replacing some of the burnable poison rods with rods containing ^{237}Np in amounts sufficient to give an initial core reactivity the same as the design value. A one-dimensional model is used to calculate a base for the reactivity-time behavior of a conventional pressurized-water reactor as designed. Requirements for substituting ^{237}Np rods are calculated. Economics for ^{238}Pu production are analyzed. The total ^{238}Pu production capability by the method presented is estimated to be between one and two thousand kilograms over a ten-year period from 1972 to 1982. (19 references) (D.C.C.)

24721 A NEW ERA OF POWER SUPPLY ECONOMICS. Swengel, F. M. Power Eng.; 74: 30-8(Mar 1970).

Cost factors related to the construction, operation, and maintenance of power reactors in the U. S. are analyzed. Comparisons are presented for power production costs for 1960, 1970, and 1980.

Comparisons are also presented for coal-fired, oil-fired, gas turbine, and nuclear power plants. (D.C.C.)

24722 PWR SIMULATOR TRAINING. Deddens, J. C. Power Eng.; 74: No. 4, 48-50(Apr 1970).

A training schedule utilizing a simulator is presented for pressurized-water reactor operators. Description of the simulator is included. (D.C.C.)

24723 ELECTRIC UTILITY INDUSTRY: FUTURE FUEL REQUIREMENTS 1970-1990. Gambs, Gerard C. (Gibbs and Hill, Inc., New York). Mech. Eng.; 92: No. 4, 42-8(Apr 1970).

Electric power demands in the U. S. for 1970 to 1990 are predicted. Fuel availability and requirements for predicted power demands are analyzed. The utilization of core, natural gas, petroleum, and nuclear fuels for power production in the U. S. is discussed. (D.C.C.)

24724 AN ANALYSIS OF THE AVAILABILITY OF THE CENTRAL ELECTRICITY GENERATING BOARD'S NUCLEAR POWER STATIONS. Dixon, F.; Silverleaf, D. J.; Weeks, R. J. (Central Electricity Generating Board, London). Technical Meeting No. 1/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

A number of statistics on the performance of the Board's Nuclear Stations are presented. Overall data on availabilities are given first; losses of availability have been allocated between reactors, other plant and overhaul and the contribution of individual plant items to these losses are described briefly. The forced outages caused by reactor plant failures at all Stations over their operational lives are tabulated and classified both by type of plant and type of outage. Quantitative assessment of these data has been attempted by defining and evaluating two new terms. General and particular conclusions are drawn, both from the separate approaches and from a comparison of the two approaches. The main conclusions concern the high availability and low forced outage for the Board's nuclear plant. (auth)

24725 FIVE YEAR EXPERIENCE OF NOVOVORONEZH NUCLEAR POWER STATION OPERATION. Ovchinnikov, F. J. (Novovoronezh Nuclear Power Station, USSR); Voronin, L. M.; Golubev, L. I.; Novikov, A. N.; Markov, Y. V. Technical Meeting No. 1/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The design characteristics and an analysis of the operational experience of the first unit of the Novovoronezh nuclear power station are briefly presented. (auth)

24726 CONSIDERATIONS ON FIFTEEN YEARS' EXPERIENCE IN THE FIELD OF NUCLEAR PLANT. Angelini, Arnaldo M. (Ente Nazionale per l'Energia Elettrica, Rome). Technical Meeting No. 1/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The main technical results of the experience acquired from operation of the three Italian nuclear power stations are discussed, with special reference to plant safety, reliability and economics in relation to service continuity and reserve capacity requirements. A few considerations are made on the applicability of this experience to new nuclear power projects. A brief review is made of the problems facing a station operator as a result of the numerous reactor concepts still in competition. (auth)

24727 EXPERIENCE AT THE YANKEE AND THE CONNECTICUT YANKEE NUCLEAR POWER STATIONS. Minnick, L. E.; Vandenburgh, D. E. (Yankee Atomic Electric Co., Boston). Technical Meeting No. 1/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The operating histories of the Yankee and the Connecticut Yankee power plants are briefly reviewed. Significant experiences with the performance of reactor and conventional plant components and systems are discussed, and power generation statistics are presented. (H.D.R.)

24728 STATUS OF DRESDEN NUCLEAR POWER STATION. Joslin, Murray (Commonwealth Edison Co., Chicago). Technical Meeting No. 1/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Some problems which have seriously affected the plant availability of Dresden 1 are discussed in the frame of reference of the Dresden 2 and 3 design: problems associated with refueling, control rod drive maintenance and the rigorous periodic inspection of the reactor coolant system. Dresden's performance as a fuel development facility is related, including its Pu recycle program. The reasons for continued optimism for nuclear power are discussed, including excellent fuel performance, low reactor outage rate and long-range fuel cost trends, nuclear vs. coal. Status of construction and preoperational testing of Dresden 2 is given in some detail. The method by which the Dresden 1 operating organization has been expanded to take over the operation of Dresden 2 and 3 is described with emphasis on the use of the General Electric Company simulator in the training program. (auth)

24729 DRESDEN I PLUTONIUM RECYCLE PROGRAM. Roch, William F.; O'Toole, John D.; Sofer, George A. (United Nuclear Corp., Elmsford, N. Y.). Technical Meeting No. 2/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The objectives, schedule and status of the Dresden I Pu recycle demonstration program are presented. Specific design considerations are discussed and selected design details are described. The pre-irradiation experimental programs to confirm design methods are outlined and fabrication handling problems are assessed. (auth)

24730 URANIUM ENRICHMENT WITHIN THE FUEL CYCLE IN JAPAN. Imai, Ryukichi (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo; 16: No. 1, 12-14(Jan 1970). (In Japanese).

Light-water reactors are used in most of the atomic power stations in Japan, and a sound fuel cycle is indispensable to secure the efficient use of nuclear fuel. In this connection, U enrichment, associated with the cycle, is described. Atomic power generation in Japan is supposed to be 40,000,000 to 50,000,000 kW in 1985, and 160,000,000 to 200,000,000 kW in 2000. The amount of U enrichment required depends on diverse factors. By the U.S.-Japan agreement on atomic energy, U enrichment is ensured up to about 1998 for the reactor plants whose construction is started by 1972, and the estimated amount in 161 tons of ^{235}U. The capacity in the U.S. is not necessarily sound and sufficient. The international joint establishment of U enrichment in Europe is also reviewed in this connection. The effort of developing gaseous diffusion and centrifugal separation in Japan is described. (NSA of Japan)

24731 ON THE ESTABLISHMENT OF NUCLEAR FUEL CYCLE IN JAPAN. Imai, Ryukichi (Japan Atomic Power Co., Tokyo). Genshiryoku Kogyo; 16: No. 1, 4-7(Jan 1970). (In Japanese).

With the progress of nuclear power generation especially, with light-water reactors, the establishment of a sound fuel cycle in Japan is important for the efficient use of nuclear fuel. The prospective fuel cycle in Japan is described. Light-water reactors will be the main type in atomic power generation for the time being. In Japan, the establishment of autonomous fuel cycle concerns the development of advanced thermal reactors and fast breeder reactors. As Japan depends largely on the import of fuel, in order to achieve the efficient use of nuclear fuel, sound nuclear fuel cycle is important. The output of the fuel industry in the early 1980s will be 150,000 to 180,000 million yen per year, but about 72% of this may not be handled within the country. U resources development, fuel enrichment, and fuel fabrication problems are examined. (NSA of Japan)

24732 PWR ATOMIC POWER STATIONS. Atomu; 15: 32-41(Jan 1970). (In Japanese).

Atomic power stations, employing PWRs, are described. The operation records of the PWR plants in Rowe, Mass., U.S.A., in Belgium, and in Conn., U.S.A., are shown. PWRs are the most in number, surpassing BWRs and AGRs. The No. 1 PWR plant in the Mihama Power Station, with the output of 340 MW(e), is described. The containment vessel, turbine, generator, and control-rod drive are discussed. (NSA of Japan)

24733 OPERATION OF THE TOKAI POWER STATION OF JAPC IN RECENT YEARS. Imai, Yoshio (Japan Atomic Power Co., Tokai). FAPIG (Tokyo); No. 51, 154-60(Nov 1968). (In Japanese).

The Tokai Power Station employs a Calder Hall type reactor. The power station, the first in Japan to generate electricity by nuclear energy on a commercial basis, has the output of 160 MW(e). The operation of the reactor plant was suspended in December 1967, due to the unexpected damage at the conduit pipe of a CO_2-gas circulator. In April 1968, the operation was restarted, and from September 1969, the operation was suspended again for its regular inspection. During the period of operation, a

test was made on the fuel exchange under loaded condition with fuel exchanger A. A stepped decline of output occurred intermittently during the operation, and the cause for this is now being investigated by means of mockups. Furthermore, the leak in a heat exchanger occurred in August, which was caused probably by erosion, unlike the previous leak by vibration. The operational condition of the Tokai Power Station is also described. (NSA of Japan)

Safety and Siting

Refer also to abstracts 22805–22807, 22809, 22810, 22814, 22815, and 22818.

24734 (ACNP-68505-J) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME X. HEALTH PHYSICS PROCEDURES. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Jun 1968. Contract AT(11-1)-850. 76p. Dep. CFSTI.

The operating manual contains information related to health physics under the following headings: responsibilities; radiation protection guides; radiation area posting requirements; personnel dosimetry; radiation monitoring instrumentation; radiation and contamination control; decontamination; radioactive material disposal, storage, and shipment; and orientation and training. (D.C.C.)

24735 (DOCKET-1155-27) LA CROSSE BOILING WATER REACTOR. Water Level Instrumentation. (Dairyland Power Cooperative, La Crosse, Wis.). 7 Apr 1970. 5p. Dep. CFSTI.

24736 (DOCKET-1155-28) LA CROSSE BOILING WATER REACTOR. Power Range Nuclear Instrumentation; Technical Specifications Changes. (Dairyland Power Cooperative, La Crosse, Wis.). 13 Apr 1970. 70p. Dep. CFSTI.

24737 (DOCKET-1155-29) LA CROSSE BOILING WATER REACTOR. Primary System Sensitized Nozzle Safe-End Replacement. (Dairyland Power Cooperative, La Crosse, Wis.). 16 Apr 1970. 293p. Dep. CFSTI.

24738 (DOCKET-1155-31) LA CROSSE BOILING WATER REACTOR. Environmental Survey Program Plans. (Dairyland Power Cooperative, La Crosse, Wis.). Mar 1970. 15p. Dep. CFSTI.

24739 (DOCKET-1155-32) LA CROSSE BOILING WATER REACTOR. Fuel Pin Bowing Study, Suppl. 2. (Dairyland Power Cooperative, La Crosse, Wis.). 27 Apr 1970. 20p. (NAI-70-32). Dep. CFSTI.

Control rod reactivity worths are presented. The reloading pattern for the core is illustrated. Axial power distributions are calculated. (D.C.C.)

24740 (DOCKET-50003-36) INDIAN POINT STATION, UNIT NO. 1. Results of Tests of the Steam Supply System. (Consolidated Edison Co. of New York, Inc., New York). 15 Apr 1970. 9p. Dep. CFSTI.

Special tests to determine the power capability of the steam supply system operating with three primary coolant loops are described. Tests results are presented. (D.C.C.)

24741 (DOCKET-50003-37) INDIAN POINT STATION, UNIT NO. 1. Core B, Cycle 4: Design and Operating Characteristics. (Consolidated Edison Co. of New York, Inc., New York). 24 Apr 1970. 11p. Dep. CFSTI.

24742 (DOCKET-50003-38) INDIAN POINT STATION, UNIT NO. 1. License No. DPR-5. Technical Specifications Change No. 39. (Division of Reactor Licensing (AEC), Washington, D. C.). 27 Apr 1970. 3p. Dep. CFSTI.

For Consolidated Edison Co. of New York, Inc., New York.

Changes in the X and Y fuel element locations in the reactor core are described. (D.C.C.)

24743 (DOCKET-50016-36) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Operator Retraining Program. (Power Reactor Development Co., Detroit, Mich.). 22 Apr 1970. 3p. Dep. CFSTI.

24744 (DOCKET-50133-30) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Operator Retraining Program. (Pacific Gas and Electric Co., San Francisco, Calif.). 10 Apr 1970. 4p. Dep. CFSTI.

24745 (DOCKET-50133-31) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 27 (Formerly Proposed Change No. 29). (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Apr 1970. 3p. Dep. CFSTI.

For Pacific Gas and Electric Co., San Francisco, Calif.

Design parameters for Jersey Nuclear Type 3 fuel elements are presented. (D.C.C.)

24746 (DOCKET-50133-32) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications Proposed Change No. 30. (Pacific Gas and Electric Co., San Francisco, Calif.). 28 Apr 1970. 4p. Dep. CFSTI.

Modifications required for a second manual scram switch are described. (D.C.C.)

24747 (DOCKET-50171-46) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Operator Retraining Program. (Philadelphia Electric Co., Pa.). 7 Apr 1970. 7p. Dep. CFSTI.

24748 (DOCKET-50206-53) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operator Retraining Program. (Southern California Edison Co., Los Angeles). 8 Apr 1970. 22p. Dep. CFSTI.

24749 (DOCKET-50213-35) CONNECTICUT YANKEE ATOMIC POWER PLANT. License No. DPR-14. Supplement No. 2 to Proposed Change No. 12. (Connecticut Yankee Atomic Power Co., Hartford). 3 Apr 1970. 13p. Dep. CFSTI.

Operating requirements for the emergency core cooling system are presented. Restrictions for auxiliary power systems are listed. Testing requirements for emergency core cooling system and auxiliary power system are described. Design limits for diesel generators, piping systems, pumps, and valves are listed. (D.C.C.)

24750 (DOCKET-50213-36) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operator Retraining Program. (Connecticut Yankee Atomic Power Co., Hartford). 10 Apr 1970. 14p. Dep. CFSTI.

24751 (DOCKET-50219-67) OYSTER CREEK NUCLEAR GENERATING STATION, UNIT NO. 1. Operator Retraining Program. (Jersey Central Power and Light Co., Morristown, N. J.). 3 Apr 1970. 2p. Dep. CFSTI.

24752 (DOCKET-50219-68) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Flood Protection. (Jersey Central Power and Light Co., Morristown, N. J.). 16 Apr 1970. 35p. Dep. CFSTI.

24753 (DOCKET-50219-69) OYSTER CREEK NUCLEAR GENERATING STATION, UNIT NO. 1. Pre-Operational Environmental Radiation Survey, February 1966–December 1968. (Jersey Central Power and Light Co., Morristown, N. J.). 9 Apr 1970. 88p. Dep. CFSTI.

24754 (DOCKET-50219-70) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Control Rod Drives. Status Report. (Jersey Central Power and Light Co., Morristown, N. J.). 21 Apr 1970. 2p. Dep. CFSTI.

24755 (DOCKET-50220-37) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Core Spray Nozzle Safe End. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). 27 Mar 1970. 54p. Dep. CFSTI.

For Niagara Mohawk Power Corp., Syracuse, N. Y.

Analysis of a water leak in the core spray nozzle safe end is presented. Results of nondestructive testing, sample removal, and photomicroscopy are included. (D.C.C.)

24756 (DOCKET-50220-38) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Operator Retraining Program. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 15 Apr 1970. 3p. Dep. CFSTI.

24757 (DOCKET-50220-39) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. Request for Amendment to License to Increase Power Level. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 20 Apr 1970. 136p. Dep. CFSTI.

24758 (DOCKET-50237-40) DRESDEN NUCLEAR POWER STATION, UNIT 2. Modification to Inner Screens on Control Rod Drives. (Commonwealth Edison Co., Chicago, Ill.). 17 Apr 1970. 2p. Dep. CFSTI.

24759 (DOCKET-50237-41) DRESDEN NUCLEAR POWER STATION, UNIT 2. Storage Tank Valve Malfunction. (Commonwealth Edison Co., Chicago, Ill.). 17 Apr 1970. 2p. Dep. CFSTI.

24760 (DOCKET-50247-34) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 17 (Includes Final Facility Description and Safety Analysis Report, Suppl. 8). (Consolidated Edison Co. of New York, Inc., New York). 17 Apr 1970. 260p. Dep. CFSTI.

Design parameters of the hydrogen recombines system are presented. Performance limits of the ventilation systems for the control and equipment rooms are described. Personnel qualifications and requirements for reactor testing and operation are included. Cooling system quality assurance requirements are revised. Performance requirements for engineered safeguards are described. (D.C.C.)

24761 (DOCKET-50254-15) QUAD-CITIES STATION, UNITS 1 AND 2. Contained Burnable Neutron Absorber as Supplementary Control. [Preliminary Safety Analysis Report], Amendment 9. (Commonwealth Edison Co., Chicago, Ill. Iowa-Illinois Gas and Electric Co., Davenport, Iowa). 3 Apr 1970. 11p. (DOCKET-50265-12). Dep. CFSTI.

Design parameters of $Gd_2O_3-NO_2$ burnable absorber rods are presented. Performance requirements of the burnable absorber rods are described. (D.C.C.)

24762 (DOCKET-50261-27) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Increase in Power Levels to 2200 MWt. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 16 Apr 1970. 4p. Dep. CFSTI.

For Carolina Power and Light Co., Raleigh, N. C.

24763 (DOCKET-50266-18) POINT BEACH NUCLEAR PLANT, UNITS NO. 1 AND 2. [Preliminary Safety Analysis Report], Amendment 4. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). 23 Mar 1970. 273p. (DOCKET-50301-15). Dep. CFSTI.

Revised information on containment structure stress requirements is presented. Flow diagrams for containment ventilation and heat removal systems are included. Leak tests for coolant loops and containment systems are described. Meteorological data for the site are included. Seismic stress limits on containment structures are described. (D.C.C.)

24764 (DOCKET-50269-13) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 11 (Includes Final Safety Analysis Report, Rev. 4). (Duke Power Co., Charlotte, N. C.). 20 Apr 1970. 522p. (DOCKET-50270-13; DOCKET-50287-10). Dep. CFSTI.

Revised data on site meteorology are presented. Programs of initial tests are described. Engineered safeguards for hydrogen removal after coolant loss accident are analyzed. Personnel responsibilities for operating and emergency conditions are described. Operating limits for control systems and engineered safeguards are presented. Stress requirements for prestressed concrete containment building are listed. Performance limits on the cooling system are described. Physics calculations for the core are presented. (D.C.C.)

24765 (DOCKET-50271-20) VERMONT YANKEE NUCLEAR POWER STATION. Final Safety Analysis Report, Vol. 3. [Preliminary Safety Analysis Report, Amendment 10]. (Vermont Yankee Nuclear Power Corp., Rutland). 12 Jan 1970. 541p. Dep. CFSTI.

Information on Vermont Yankee Power Reactor is presented under the following broad topics: Station Electrical Power Systems; Radioactive Waste Systems; Station Auxiliary Systems; Station Power Conversion Systems; Station Structures; Conduct of Operations; and Station Safety Analysis. (D.C.C.)

24766 (DOCKET-50282-19) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Supplementary Information to the Preliminary Safety Analysis Report. (Northern States Power Co., Minneapolis, Minn.). 14 Apr 1970. 33p. (DOCKET-50306-19). Dep. CFSTI.

Design restrictions for Classes 1, 2, and 3 structures, systems, and components are presented. Stress loads for the structures, systems, and components are described. (D.C.C.)

24767 (DOCKET-50335-14) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 9. (Florida Power and Light Co.). 27 Apr 1970. 9p. Dep. CFSTI.

Revised and additional information concerning the cooling system is presented. (D.C.C.)

24768 (DOCKET-50336-11) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 7. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 20 Apr 1970. 18p. Dep. CFSTI.

Engineered safeguards are described. The failure and missile generation possibilities of the turbines are reviewed. Control system interlocks and actuation restrictions are analyzed. Operation limits for auxiliary power systems are described. (D.C.C.)

24769 (DOCKET-50344-8) TROJAN NUCLEAR PLANT. Preliminary Safety Analysis Report, Amendment 5. (Portland General Electric Co., Oreg.). 9 Apr 1970. 742p. Dep. CFSTI.

Geological and seismological studies for the reactor site are presented. Meteorological investigations are described. Design limits and requirements for reactor cooling system and containment systems and buildings are presented. Design restrictions on the emergency core cooling system, instrumentation and control systems, and auxiliary power systems are included. Waste disposal systems are described. Personnel qualifications are presented. Safety analysis for coolant loss conditions is included. Quality assurance requirements are described. (D.C.C.)

24770 (DOCKET-50346-7) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 3. (Toledo Edison Co., Ohio). 22 Apr 1970. 700p. Dep. CFSTI.

Addition and revised data on site meteorology are presented. Cooling system and containment system design limits are described. Performance requirements for engineered safeguards and auxiliary power systems are analyzed. Safety limits on all reactor systems are included. Radioactive waste disposal systems are described. Seismic stress limits on systems and structures are analyzed. (D.C.C.)

24771 (DOCKET-50346-8) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 4. (Toledo Edison Co., Ohio). 29 Apr 1970. 12p. Dep. CFSTI.

The maximum possible and maximum probable earthquake hazards for the reactor site are analyzed. (D.C.C.)

24772 (DOCKET-50354-7) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Public Service Electric and Gas Co., Newark, N. J.). 17 Apr 1970. 64p. (DOCKET-50355-7). Dep. CFSTI.

Drawings indicating the layout of buildings and structures on the reactor site are included. Geological and hydrological data for the site are presented. (D.C.C.)

24773 UPDATED EARTHQUAKE ENGINEERING. Keith, Edward J.; Keever, Robert E. Power Eng.; 74: No. 4, 37-9 (Apr 1970).

A revised method for analyzing seismic requirements for power reactors is presented. The method consists of a systematic analytical procedure that starts with design limits of reactor components and establishes seismic forces that may be tolerated by the components. (D.C.C.)

24774 LEAK TESTING OF TWO NUCLEAR REACTOR CONTAINMENT VESSELS AT TARAPUR. Sastry, A. M.; Dharia, D. M. (Bechtel India Ltd., Tarapur, India). J. Inst. Eng. (India); 48: Pt. EL-4, 640-7(Apr 1968).

The containment vessel is a safety device to isolate the harmful radiation of a reactor from the environs in case of an accident. There are two such steel vessels at Tarapur, which were leak-tested to ensure the high integrity required of them. The general test principles are explained with particular reference to the actual test conducted at Tarapur. (auth)

24775 SAFETY OF NUCLEAR POWER STATIONS. Renaudin, Denys (Societe pour l'Industrie Atomique, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 81, 16-20(Jan-Feb 1970). (In French). (CONF-691119-1).

From Meeting on the Development of Safety Systems in Nuclear Industries, Paris, France.

The problem of the safety of the population living near nuclear power stations is treated. A short historical review of safety studies is given as well as examples of real accidents which contributed to a better knowledge of safety problems. In France, the CEA is in charge of the development of safety studies. In the future, they will be based on the probability of emission of given quantities of curies, according to the method proposed by Farmer. (France)

24776 TRENDS IN REACTOR SAFETY. Laurence, G. C.; Boyd, F. C. (Atomic Energy Control Board of Canada, Ottawa, Ont.). Technical Meeting No. 5/1 of NUCLEX 69: 2nd Interna-

tional Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Some accidents, which are recalled, have added considerably to the understanding of reactor safety, but there are some lessons from them that should receive more emphasis. There has been some success in expressing safety requirements more precisely including those which relate to the location of the plant. Consideration of the probability of events is inevitable with a need to give it some quantitative description, but there has been a tendency to assume probabilities without the support of tests or operating experience, and to make claims of very low probabilities of coincident events that ignore the possibilities of their causal interdependence. The misleading use of hackneyed phrases is deplored; for example, the expression "maximum credible accident" may lead to oversight of some bad accidents that are not a negligible risk for very large nuclear power stations in very densely populated areas. (auth)

24777 TECHNIQUES OF REACTOR AND SITE HAZARD ASSESSMENT. Beattie, J. R. Technical Meeting No. 5/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Risks from releases of fission products from reactor accidents are reviewed, and it is shown that they can be evaluated numerically for a reactor which satisfies a probability vs curie release criterion of the kind suggested by F. R. Farmer in 1967. Examples are given in the form of f–N curves, which relate probability to the occurrence of a given number of cases of thyroid cancer in the population round the reactor. It is concluded that variations in population distribution in practice have only a minor effect on the evaluated hazard. This confirms the primary importance of improving reactor safety. It is argued that this can best be done using the probability approach to reactor safety. (auth)

24778 QUALITY ASSURANCE FOR NUCLEAR POWER STATIONS. Gitterman, H. (Burns and Roe, Inc., New York); Stauffer, M. Technical Meeting No. 5/9 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

The need for quality control and assurance in the construction and operation of nuclear power plants is discussed, and the approach to quality assurance in the U. S. is described. The tasks and responsibilities of the regulatory agency, utility or owner, and construction contractors are defined. (H.D.R.)

Steam and Power Conversion Systems

24779 (CONF-690549) EXCHANGE OF EXPERIENCE ON INSTALLATION PARTS OF NUCLEAR POWER STATIONS. Volume 1. Allocutions and Reports. Meeting on Actual Technological Problems of Steam Turbines of Nuclear Stations, Brussels, May 8, 1969. (European Communities, Brussels (Belgium). Commission). 156p. (In French). Dep. CFSTI (U. S. Sales Only).

Included are 7 papers on the design, operation, control, and maintenance of steam turbines for nuclear power plants. Discussed in separate papers are: (1) movement of variable blades by a discontinuous distribution of steam injection to the first stage of a compound turbine; (2) damage caused to the turbine blades of the Gundremmingen power plant; (3) system for moisture separation for the turbine of the Dodewaard power plant; (4) control systems for safe operation of high pressure steam turbines for nuclear power plants; (5) control of the operation of steam turbines of Italian nuclear power plants; (6) inspection problems of steam turbines for nuclear power plants; and (7) present trends in the design of steam turbines for boiling water reactors. (H.D.R.)

24780 LOAD FREQUENCY CONTROL OF A BOILING WATER REACTOR WITH TWO TURBINES. Bremer, P. Technical Meeting No. 6/9 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

There has developed a certain trend from the utilities to consider twin-turbine nuclear power stations in order to comply with particular conditions. The additional requirements concerning load frequency control are analyzed and illustrated for the case of a boiling water reactor. (auth)

Power Reactor Development

Refer also to abstracts 22850, 23536, and 24898.

24781 (ANL-7669) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, FEBRUARY 1970. (Argonne National Lab., Ill.). 30 Mar 1970. Contract W-31-109-eng-38. 143p. Dep. CFSTI.

Highlights of project activities for February 1970 are summarized. LMFBR physics development, component development, and Na technology are reviewed. Operations and analysis of ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The EBR-2 research and development projects, fuel fabrication, and operations are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, and LMFBR safety studies are reported. (D.C.C.)

24782 (GA-9875) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending December 31, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Jan 1970. Contract AT(04-3)-633. 179p. Dep. CFSTI.

BORON—diffusion from boronated graphite reactor control elements, compressive load and high temperature effects on
CARBON—properties of pyrolytic, as coating for reactor fuel particles
FISSION PRODUCTS—release from TRISO coated fuel particles, effects of temperature on
FORT ST. VRAIN POWER REACTOR, UNIT 1—fuel management program development for
—kinetics of, analysis of
—fuel element design and testing for
—fuel particles for, fabrication and irradiation testing of coated
—fuel transfer machine for, development and testing of
GRAPHITE—properties of binder and filler materials for coated particle fuel rods
—fabrication for Fort St. Vrain reactor core structure
—radiation effects on, fast neutron
NEUTRONS, FAST—effects on Fort St. Vrain coated fuel particles and core graphite
REACTOR CONTROL ELEMENTS—boron transport from boronated graphite, compressive load and high temperature effects on
REACTOR FUEL ELEMENTS—development of bonded coated particles in graphite matrix for Fort St. Vrain
REACTOR FUELS—development of coated particle, for Fort St. Vrain
—radiation effects on TRISO coated thorium carbide (ThC_2)–uranium carbide (UC_2) particle type, fast neutron
—expansion of coated particle beds, effects of steam hydrolysis on
REACTOR LOADING MACHINES—development of Fort St. Vrain
SILICON CARBIDES—properties as coating for reactor fuel particles
THORIUM CARBIDES—ThC_2–UC_2, radiation effects on TRISO coated particles of, fast neutron
URANIUM CARBIDES—ThC_2–UC_2, radiation effects on TRISO coated particles of, fast neutron (H.D.R.)

24783 (JAERI-1177(Pt.1)) JAERI's CONCEPTUAL DESIGN OF THE JAPAN FAST EXPERIMENTAL REACTOR. (Japan Atomic Energy Research Inst., Tokai). Jul 1968. 183p. Dep. CFSTI (U. S. Sales Only).

The primary objective of the present conceptual design is to prepare for the construction of Japan Fast Experimental Reactor (JFER) which will enable various fast reactor engineering experiments such as fast flux irradiation work on fuels. The following subjects of the design are described: the general philosophy and specific aspects of the present design; the nuclear characteristics including burn-up behavior of the reactor core; the thermal hydraulic characteristics of the core; the mechanical design of the reactor vessel, the shielding plugs, the internal structure of the vessel, and the core structure including fuel assembly; and the fuel handling system design. (auth)

24784 (NAA-SR-12570) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, July–September 1967. (Atomics International, Canoga Park, Calif.). 24 Mar 1970. Contract AT(04-3)-701. 210p. Dep. CFSTI.

AEROSOLS—production in LMFBR sodium fires, release and transport following
ALLOYS—electronic structure of, relation of superconductivity and normal state

CHROMOSOMES—radiation effects on molecular structure of, mechanisms of chemical reactions in
CORROSION LOOPS—operation of liquid sodium, for testing of Type 304 stainless steel fuel element cladding
CRITICAL ASSEMBLIES—physics calculations for, use of Monte Carlo methods for
FISSION PRODUCTS—release from LMFBR fuel elements during cladding failure, radiological hazards index for
FUSED SALTS—properties of, high temperature chemical and physical
HALLAM POWER REACTOR—retirement activities during July to September 1967
HEATERS—development of high heat flux, for operation in liquid sodium corrosion loop
HELIUM—effects on tensile properties of LMFBR fuel cladding materials
LIQUID METAL FAST BREEDER REACTOR—aerosol release and transport from sodium fires in
—coolant boiling in, characteristics of liquid sodium
—fission product behavior in, effects of fuel cladding failure on
—fuel cladding failure in, radiological hazards index for
—fuel cladding for, effects of liquid sodium on mechanical properties of Type 304 stainless steel
—fuel cladding for, mechanical properties of Type 304 and Type 316 stainless steel
—fuel cladding materials for, effects of helium on degradation of
—reactivity in, techniques for measurement of fast neutron spectra Doppler
METALS—chemistry of solutions of metal salts and, high temperature
—electronic structure of, relation of superconductivity and normal state
NEUTRON CROSS SECTIONS—evaluation of, development of automated procedures for
ORGANIC COMPOUNDS—radiolysis of, chemical and physical processes for
RADIATION—effects on molecular structure of chromosomes, chemical changes from
—effects on physical properties of crystalline solids
REACTIVITY—measurement of LMFBR fast neutron spectra Doppler, techniques for
REACTORS, FAST—neutron flux spectra analysis of, development of methods for region dependent
—physics calculations for, use of Monte Carlo methods for
REACTOR FUEL ELEMENTS—cladding failure in LMFBR, radiological hazards index for
—cladding for LMFBR, effects of liquid sodium on mechanical properties of Type 304 stainless steel
—cladding for LMFBR, mechanical properties of Type 304 and Type 316 stainless steel
—cladding materials for LMFBR, effects of helium on degradation of
REACTOR FUELS—preparation of tungsten doped uranium carbide (UC)
REACTOR SAFETY—fuel cladding failure in LMFBR, radiological hazards index for
—sodium fires in LMFBR, aerosol release and transport from
SALTS—chemistry of solutions of metals and, high temperature
SODIUM—boiling characteristics of liquid, in LMFBR coolant channels
—neutron spectra in liquid, measurement of
—solvent properties of liquid, for metals and nonmetals
SODIUM REACTOR EXPERIMENT—retirement activities during July to September 1967
SOLIDS—physical properties of crystalline, effects of radiation on
STAINLESS STEEL—mechanical properties of tubes of Type 304 and Type 316
—mechanical properties of Type 304, effects of liquid sodium on
TUBES—mechanical properties of Type 304 and Type 316 stainless steel
URANIUM CARBIDES—preparation of tungsten doped (D.C.C.)

24785 (RCN–114) FAST REACTOR PROGRAMME. Second Quarter 1969 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Dec 1969. 73p. Dep. CFSTI (U. S. Sales Only).

The RCN program activities in reactor physics, fuel performance, radiation damage in canning materials, corrosion behavior in canning materials, aerosol research, and heat transfer and hydraulics are summarized. (auth)

24786 SLOW PACE FOR A FAST BREEDER. Elec. Light Power (Boston); 48: 52–3; 56–8(Mar 1970).

The development of fast breeder power reactors in the U. S. is reviewed. Factors related to the development schedule are analyzed. (D.C.C.)

24787 THE EVOLUTION OF CANDU–PHW POWER REACTORS IN CANADA. Bate, D. L. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Technical Meeting No. 3/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Canada has two PHW power stations operating and two under construction; ten power reactors in all. The NPD prototype station has provided a fund of information to be applied to future designs. Douglas Point achieved full power early in 1968 but has suffered a number of running-in mechanical troubles, none of which has proven insurmountable or basic to the plant designs. Major features of the CANDU–PHW reactor line and the evolution of the design of these features are described, relative to these two operating stations and the two under construction. Capital costs have been reduced and fuelling costs are down to about ½ mill/kWh. Unit energy costs for the current designs for Ontario Hydro are predicted to be 3.0 millidollars/kWh. based on 1969 U. S. dollars, i.e. excluding escalation. (auth)

24788 SWEDISH PRESSURE VESSEL BHWRs. Margen, P. H. (Aktiebolaget Atomenergi, Stockholm); Haga, I.; Swenson, B. Technical Meeting No. 3/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The simplicity and safety of the natural circulation BHWR's with concrete pressure vessels of integral design and the attractive fuel cycle are described. Results from Marviken BHWR operation and the Scandinavian model concrete pressure vessel testing are expected to provide residual technology demonstration. This and the results of a current evaluation study of a 750 MW(e) natural uranium version are expected to prove the viability of the concept. Experience, designs characteristics, and economy are reviewed. (auth)

24789 HIGH TEMPERATURE REACTORS: PRESENT DESIGNS AND FUTURE TRENDS. Cameron, P. J.; Acciarri, P.; Dehon, C. V.; Marggraf, G. Technical Meeting No. 3/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The advantages of the HTR are explained, and the main parameters are indicated. The principle features of the design are described, typical costs are given, and the development potential of the system is outlined. (auth)

24790 THE HTR–CONSTRUCTION LINE WITH ADVANCED CONVERTER REACTORS. Hennings, U. (Brown Boveri/Krupp Reaktorbau GmbH, Duesseldorf); Mueller, H. W.; Rausch, W.; Endres, W. Technical Meeting No. 3/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

The High Temperature Reactor is one of the advanced converter systems. It was originally supposed to be an intermediate line between conventional reactors and fast breeders. This line will be able to compete with conventional reactors in economics within a few years. Moreover in the long run, it will keep an important part in the energy market beside the fast breeders. (auth)

24791 THE HTR: CHOICE OF STYLE AND PERFORMANCE. Insch, G. M.; Thorn, J. D.; Hurst, J. N. Technical Meeting No. 3/9 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The design choices available for the introduction of the Mk III H.T.R. are examined. Optimization and design parameters are considered. The future use of closed cycle gas turbine plant is foreseen. (auth)

24792 PFR DESIGN AND CONSTRUCTION: A PROGRESS STATEMENT. Campbell, R. H. Technical Meeting No. 4/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The main building and civil work for the PFR has been completed at Dounreay. The primary vessel and its associated leak jacket have been fabricated at site and work on all the other main reactor components is progressing. The assembly of these is due to be completed at the end of 1971 for commissioning tests, including a dynamic water test of the primary circuit, to begin in 1972. (auth)

24793 INDUSTRIAL EXPERIENCE ON 300 MWe PROTOTYPE FAST REACTOR, INFLUENCES FUTURE DESIGNS. Shaw, M. K. (English Electric Co., Whetstone, Eng.); Worley, N. G.; Waters, J. D. Technical Meeting No. 4/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Early industrial involvement with the U.K.A.E.A. in the design of the Prototype Fast Reactor, ensured that British industry was able to participate in the formative stages of the project and understand its aims. The investment made by industry in design, experimental, and manufacturing facilities, the contribution of three major companies in the Prototype Fast Reactor, and their plans for the future are reviewed. (auth)

24794 FAST REACTORS AND SODIUM TECHNOLOGY IN FRANCE. Vendryes, G. (CEN, Saclay, France); Faure, J.; Ertaud, A. Technical Meeting No. 4/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

The main features of the French Fast Reactor Development Programme are described and the principal results are summarized. The French industrial activities in the field of sodium technology are reviewed. (auth)

24795 THE BN-600 FAST REACTOR. Leipunskii, A. I.; Golovnin, I. S.; Kugushev, N. M.; (and others). Technical Meeting No. 4/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The atomic power plant BN-600 with the fast reactor will produce 600 MW(e) when working at nominal rating. The reactor thermal power is 1470 MW. Heat is removed by means of a three-circuit scheme: liquid sodium in the I and II circuits, water and steam in III. The average sodium temperature at the reactor outlet is 550°C, the steam temperature is 500°C. A scheme with steam reheating by the secondary-circuit sodium is used which permits high efficiency of the cycle (about 41%). Physical, thermal, and technical characteristics of the reactor, main components of heat transfer circuits, and some data concerning the atomic power plant as a whole are presented. In particular, some considerations on the choice of basic parameters are presented, and descriptions of the flow diagram, the reactor and core design, of sodium pumps, heat exchangers and steam generators, and of the fuel-handling system are given. (auth)

24796 A DEVELOPMENTAL GAS-COOLED FAST BREEDER REACTOR PLANT. Fortescue, P. (Gulf General Atomic Inc., San Diego, Calif.); Melese-d'Hospital, G.; Peak, J.; Meyer, L. Technical Meeting No. 4/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

A 330 MW(e) Gas-Cooled Fast Breeder Reactor (GCFR) demonstration plant is being designed by Gulf General Atomic Incorporated in cooperation with utilities in the United States. The whole primary system including steam generators and the main and auxiliary helium circulators is enclosed within a prestressed concrete pressure vessel, itself within a containment vessel. The fuel element is made up of bundles of metal-clad mixed UO_2-PuO_2 pins which are collectively vented to a trapping system separate from the main coolant. GCFR fuel development is based on LMFBR technology, and the plant components are similar to those of HTGR systems. (auth)

24797 COMPARISON BETWEEN THE DEVELOPMENT PROBLEMS OF THE DIFFERENT FAST BREEDER REACTOR CONCEPTS. Chermanne, J. (Societe Belge pour l'Industrie Nucleaire, Brussels). Technical Meeting No. 4/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Technological development problems of fast breeder reactors and their operational and economical prospects are examined. Sodium and gas cooled fast reactors are the concepts having the best potentialities, the second one being in fact the outcome of the gas cooled reactor line. The steam cooled fast reactor had to be abandoned because, while involving greater development and operation difficulties, it did not offer the advantages of both other concepts. (auth)

24798 A GAS-COOLED FAST REACTOR USING A DIRECT CYCLE GAS TURBINE. Lys, L. A.; Utzinger, E. (Swiss Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). Technical Meeting No. 4/8 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

A design of a 1000 MW(e) gas cooled fast reactor using direct cycle gas turbines for power generation is presented. The fuel is mixed PuO_2-UO_2 in the form of metal clad fuel rods. It is shown that, due to the inherently low fuel cycle cost characteristic of this reactor type, attractive performance figures can be obtained using can materials based on present day technology. (auth)

24799 NUCLEAR POWER IN GERMAN DEMOCRATIC REPUBLIC. Steenbeck, M. (Vorsitzender des Forschungsrates, Berlin). Kernenergie; 12: 309-13(Oct 1969). (In German).

The nuclear research center of the DDR was founded in 1956 at Rossendorf. The cyclotron is used mainly for nuclear physics studies and a WWRS research reactor for production of radioisotopes and studies of reactor techniques. As prototype for a nuclear power plant, a 70 MW(e) installation was built at Rheinsberg. Design and major parts of the plant were produced in Russia. A large scale nuclear power plant is under construction at Lubmin near the Baltic Sea. Its design as well as its major components is of Russian origin. (H.B.G.)

24800 STATUS REPORT 1970 ON FAST BREEDER PROJECTS. Haefele, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 15: 171-5(Apr 1970). (In German).

An annual report for 1969 is presented with respect to basic research on fast breeders. Fuel elements were studied under zero power condition to obtain information about axial flux distribution, action of control rods, and Na void coefficients. Extensive work was performed on Na technology, especially with respect to corrosion effects on the reactor core, Na boiling, and transient boiling. Instrumentation is discussed mainly with respect to three types of measuring devices intended for attachment at the head of each fuel element: thermocouples, flow meters, and gas detectors. Bundles of 77 fuel elements were irradiated with fast neutrons and cooled with Na. In addition to the Na studies, further experimental data were obtained about the steam-cooled and He-cooled fast breeder reactors. (H.B.G.)

24801 ADVANCED THERMAL REACTOR IN JAPAN. Inoue, Chikara (Science and Tech. Agency, Tokyo). Genshiryoku Kogyo; 16: No. 2, 8-10(Feb 1970). (In Japanese).

The advanced thermal reactor (ATR) is defined as a nuclear reactor with a conversion ratio of more than 0.7. Essentially, however, it is an improved type of thermal reactor in both technique and economy. The principles on which the development of ATR in Japan is based are efficient use and diversifying of nuclear fuel, high economy of an ATR, and practical use as early as possible. Considerations leading finally to the development of ATR are discussed. (NSA of Japan)

24802 TECHNOLOGICAL ASSESSMENT OF THE ATR. Aoki, Shigebumi (Tokyo Inst. of Tech.). Genshiryoku Kogyo; 16: No. 2, 11-15(Feb 1970). (In Japanese).

The ATR being developed in Japan is described from its technological aspects. The D_2O moderated, boiling light-water cooled reactor uses slightly enriched U as the initial fuel, and then can be operated by natural U enriched with Pu. The prototype ATR is of rated output 165 MW(e), and is the mockup of a full-scale one of 500 MW(e). While not differing much from light-water reactors, the technical problems concerning pressure tubes, fuel clusters and fuel exchange are described. The technical aspect of an ATR, supplying Pu for a fast breeder reactor, is examined. The significance of the domestic development of an ATR is discussed. (NSA of Japan)

24803 STATE OF THE DEVELOPMENT OF AN ADVANCED THERMAL REACTOR (ATR), AND THE CONSTRUCTION OF A PROTOTYPE REACTOR. Kawaguchi, Keizo; Akebi, Michio; Hayashi, Kiyozumi; Iio, Hiromoto; Yoshikawa, Yuichiro (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 16: No. 2, 21-38(Feb 1970). (In Japanese).

The advanced thermal reactor (ATR) being developed in Japan is

a D_2O moderated, boiling light-water cooled reactor. The fuel is natural U with added Pu, and so the reactor can maintain its operation by being supplied only natural U. The eventual goal of the development is to build an ATR with output of 500 MW(e), while the prototype of 165 MW(e) is the start. It is required to complete the development of an ATR in a relatively short interval, before the advent of a fast breeder reactor (FBR) also developed in Japan. The construction of a prototype reactor is slated to start in 1970, and criticality in 1974. Tsuruga, Fukui Prefecture, has been decided as its site. The overall picture of the development program including conceptual design and research work, is shown. Details of design and site survey for the prototype are described. (NSA of Japan)

24804 REVIEW ON ADVANCED THERMAL REACTORS, BY THE AD HOC SUB-COMMITTEE. 2. Atomu; 15: 42-77 (Jan 1970). (In Japanese).

Development efforts in overseas countries are reviewed, and the particular type of ATR to be developed in Japan is investigated. The prototype ATR, to be constructed in Tsuruga, Fukui Prefecture, has the rated output of 165 MW(e). It is D_2O moderated and boiling light-water cooled; initial fuel is slightly-enriched uranium, and subsequently operation is maintained by natural uranium. The power cost for an ATR is examined, in comparison with that of ordinary light-water reactors. In Japan, the development of an ATR is closely connected with the saving of foreign currency, and the utilization of the resultant techniques for other areas. The relationship between the development cost and the effect is also described. (NSA of Japan)

24805 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). British Patent 1,188,929. 22 Apr 1970. Priority date 22 Mar 1968, France.

REACTORS, GAS-COOLED — core of, description of key connected parallel stacked columns of moderator for (D.C.C.)

24806 THE REACTOR CENTER NETHERLANDS IN THE SEVENTIES. II. MAJOR PROJECTS DURING 1970 TO 1980. Atoomenergie Haar Toepass.; 12: 19-30(Jan 1970). (In Dutch).

In this second of the three-article series about the future of nuclear energy in the Netherlands, the planned and anticipated development during the seventies and the role of the RCN are reviewed. It is expected that consolidated and internationally based industrial concerns will construct nuclear power plants with a total capacity of 2000 MW, involving four water-cooled reactors and using existing technology. On the other hand, new technology will be required to develop propulsion systems for fast container-carrying ships. Present international agreements may lead to the development of fuel elements for helium and sodium-cooled fast-breeder reactors. The KSTR homogeneous reactor which is currently being built at Arnhem is still being evaluated. It is expected that development of a thermonuclear reactor will be undertaken. Dutch industry is expected to provide fuel enrichment services by the gas centrifugation technique and will produce sol-gel fuel elements. Activation analysis, neutron diffraction, nuclear physics and radiation biology studies will be carried out in cooperation with the universities. RCN will provide service irradiation, waste disposal activities and will assist industry with technical documentation and the organization of reactor training courses. (TTT)

24807 THE REACTOR CENTER NETHERLANDS IN THE SEVENTIES. III. FINAL REMARKS. Atoomenergie Haar Toepass.; 12: 31-4(Jan 1970). (In Dutch).

This is the last of a series of articles by the management of RCN concerning the course of the institution during the new decade. The Dutch government promised that the Euratom-owned High Flux Reactor will be made available to researchers at the Center. Irradiation services will be offered to industrial and foreign sponsors. Training activities will be directed toward the development of new reactor types. It is planned to increase collaboration with universities by inviting a larger number of graduate students and faculty members to the Center, offering opportunities to carry out thesis work. Many RCN staff members are now teaching at several universities under various arrangements; it is planned to increase their number and the special fields covered by them. This exchange will benefit both the RCN and the universities. A list of abbreviations of nuclear industrial and government organizations is attached. (TTT)

Kinetics and Dynamics

Refer also to abstracts 24888 and 24918.

24808 (AEEW-R-674) DRAGON HIGH TEMPERATURE GAS COOLED REACTOR DYNAMIC RESPONSE MEASUREMENTS, APRIL 1969, AND OPTIMUM PARAMETER FITTING. Cummins, J. D. (Atomic Energy Establishment, Winfrith (England)). Oct 1969. 34p. (DP-Report-696). Dep. CFSTI (U. S. Sales Only). UK 5s.

Dynamic experiments were performed on Charge III, Core IV of the Dragon Reactor at 20 MW. Both terminated ramp and pseudo-random binary chain code perturbations were applied to a control rod and neutron flux and fuel thermocouple signals recorded and analyzed. Least squares fitting of parameters was carried out and an estimate of the power to reactivity coefficient and reactivity feedback time constant made. Comparison with results obtained previously indicated that there was little change in these parameters. 4 references. (auth)

24809 (BAW-10000) CORRELATION OF CRITICAL HEAT FLUX IN A BUNDLE COOLED BY PRESSURIZED WATER. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Mar 1970. 88p.

An extensive experimental program on critical heat flux is presented. Over 500 data points were obtained from a nine-rod, uniformly heated bundle, and over 350 data points were obtained from nonuniformly heated tubes and annuli. These data were used to develop design equations for calculating the critical heat flux in a nuclear reactor. This design technique should be superior to that now available because it was developed from bundle data, which more closely approach actual reactor conditions than do the tubular data on which other design techniques are based. 10 references. (auth)

24810 (BAW-10010(Pt.2)) STABILITY MARGIN FOR XENON OSCILLATIONS. ONE-DIMENSIONAL DIGITAL ANALYSIS. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). 24 Feb 1970. 21p. Dep. CFSTI.

The analysis of Xe-induced oscillations in large power reactor cores requires the use of multidimensional computer programs. One-dimensional calculations in the axial direction show that axial power shaping rods (APSRs) are adequate for controlling or damping Xe oscillations. Computer programs have been developed to process the data from the one-dimensional calculations for use in subsequent multidimensional analysis. 7 references. (auth)

24811 (EUR-4410) COSTANZA BBK: A ONE DIMENSIONAL DYNAMIC CODE FOR HIGH TEMPERATURE GAS COOLED REACTORS. Friedrich, K.; Massimo, L.; Vincenti, E. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)). 1970. 68p. (THTR-93). Dep. CFSTI (U. S. Sales Only). FF 11.-.

On the basis of the already existing COSTANZA code for liquid cooled reactors a program has been developed for the one-dimensional dynamic calculations of the high temperature gas cooled reactors. The program solves the two-group dynamic neutron diffusion equations in the radial direction. The temperature feedback on reactivity is obtained through the consideration of the temperature dependence of all of the coefficients of the two-group equations. The parameters for a consistent zero-dimensional calculation are calculated by the code. A comparison of zero and one-dimensional calculations shows that it is important to perform in one dimension the thermal calculation, while a one-dimensional neutron flux dynamic calculation is normally not necessary for the safety calculations of high temperature gas cooled reactors. 9 references. (auth)

24812 (JAERI-1187) THEORY OF REACTOR NOISE. [PART] I. Saito, Keiichi (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 148p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Neutron fluctuations in a low-power reactor are formulated under the premise that they obey linear Markoffian branching process. Formulas for various methods of noise analysis are uniformly derived from results of the basic theoretical study. Interrelations among the formulas are critically examined. A brief history of the development of the reactor noise theory is presented. The theoretical formulation from the Langevin's approach is included. The neutron transport processes from the view point that they follow stochastic branching processes are formulated. Physical structures of correlation functions and moments of the probability distribution for neutrons or detection counts are clarified with the use of tree diagrams of neutron family. Appendix summarizes nuclear data on the probability distribution and the second moment of the number of prompt neutrons emitted by a fission. Elementary explanation of the terminology of noise phenomena is also present in Appendix. (190 references) (auth)

24813 STATISTICAL UNCERTAINTY IN DOPPLER COEFFICIENT CALCULATIONS FOR FAST REACTORS. Adkins, C. R. (Carnegie-Mellon Univ., Pittsburgh); Dyos, M. W. Nucl. Sci. Eng.; 40: 159-72(May 1970).

A random sampling procedure is used to construct resonances in the unresolved region. The success of this procedure depends on the ability to determine statistically meaningful reactivity coefficients. To establish an estimate of the statistical dispersion of the Doppler effect for a carbide-fueled fast power reactor, many different resonance ladders were studied for each total angular momentum state of the compound nucleus for each isotope. It is shown that the one-standard-deviation statistical uncertainty in the calculated total Doppler effect for the core is ~3%, which is quite satisfactory. However, the statistical uncertainty in the ^{239}Pu Doppler effect was determined to be ~40% in the unresolved region, and ~35% over all energy. The manner in which the ladders are chosen is investigated, with the conclusion that any ladder, giving the proper distributions of resonance parameters, may be used. Based on these results, it may be advantageous to use the random sampling method of resonance construction in place of the usual statistical averaging procedure. This would eliminate some of the approximations inherent to these statistical averaging procedures, by including all interference and overlap effects. (10 references) (auth)

24814 AXICRP: FINITE ELEMENT COMPUTER CODE FOR CREEP ANALYSIS OF PLANE STRESS, PLANE STRAIN, AND AXISYMMETRIC BODIES. Sutherland, W. H. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Nucl. Eng. Design; 11: 269-85(Mar 1970).

Application of the finite element computer code "AXICRP" developed for the purpose of solving creep problems for plane stress, plane strain, and axisymmetric bodies of revolution is described. The code represents an extension of an elastic finite element code to include the nonlinear effects arising from creep by the use of an incremental procedure. This procedure permits the utilization of any creep law expressible in the general functional form $\Delta\epsilon_e^c = F(\sigma_e, \epsilon_e^c, T, t)$. Principal application has been to obtain the creep solution for a Fast Flux Test Facility (FFTF) hexagonal flow duct. Other applications to a thick-walled cylinder and a rectangular beam demonstrate the variety of structural geometries which can be analyzed by the program. (12 references) (auth)

Control Systems

24815 TREATING REACTOR BORATED SHIM WASTES. Dickinson, B. N. Power Eng.; 74: 39-43(Mar 1970).

The use of ion exchange resins for maintaining and treating borated shim solutions is described. A flow diagram for a pressurized-water reactor borated shim treatment system is presented. The performance of Duolite ARA-366 deborating resin is analyzed. (D.C.C.)

24816 STATIC SYSTEM FOR PROGRAMMING AND CONTROLLING THE MOVEMENT OF CONTROL RODS OF A PRESSURIZED WATER REACTOR. Szlachter, J. (Ateliers de Constructions Electriques, Charleroi, Belgium). Technical Meeting No. 6/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

The increase in power of reactors has led to a decrease in the number of control rods that can displace simultaneously, with an increase in their speed of displacement. The control rod assembly in the system described has been divided into groups which are further divided into sub-groups. The rods displace in a discontinuous manner, each sub-group being controlled by a solid-state programmer which ensures a displacement sequence of less than a second. The assembly of sub-groups making up a group is controlled by a master programmer consisting of a logic analogue converter and a distribution circuit for the sending of pulses to the slave programmers. Finally, the control of the rod coils by the slave programmer is carried out by a thyristor system which ensures a constant current mode of operation. This current control reduces the effect of the main cause of speed limitation, i.e. the coil inductance. (auth)

Shielding

24817 (CEA-N-1244) ORPHEE VI PROGRAM: ATTENUATION OF FAST NEUTRONS IN A LAMELLAR STRUCTURE OF WATER AND DENSE MATERIAL. Simon, Michel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1970. 26p. (In French). Dep. CFSTI (U. S. Sales Only).

The Orphée VI program calculates the fast neutron flux in the side shielding of a light water reactor. The attenuation in water is treated, using the formalism of a nucleus in water, which is different from the straight-line attenuation used for heavy materials. The code also makes it possible to take the positions of the control rods into account. Orphée VI has been written in Fortran IV language for IBM 360. (auth) (France)

24818 (CEA-N-1253) CALCULATION OF FLUX IN SODIUM RESERVOIR. Katz, Shlomo; Nimal, Jean-Claude; Vergnaud, Therese (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 39p. (In French). Dep. CFSTI (U. S. Sales Only).

Calculations are made of the different responses given by detectors (S, Rh, Mn/Cd) in the model of the lower shielding of Phenix placed in the reactor Harmonie, using the code Tripoli. The calculation methods make use of sources placed at the entrance of the model. The case considered is a simple one but is typical of the majority of the possibilities offered by the three-dimensional multikinetic Monte-Carlo code Tripoli. Experimental results and calculations for spherical geometry using the code Niobe are also available. (5 references) (auth)

Cooling Systems

Refer also to abstract 24834.

24819 (EURFNR-750) FLOW AND TEMPERATURE DISTRIBUTION INCLUDING COOLANT MIXING IN SODIUM COOLED FUEL ELEMENTS WITH ECCENTRIC GEOMETRY. Hofmann, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Feb 1970. 20p. (KFK-1155; SM-130/40; CONF-700307-1). Dep. CFSTI (U. S. Sales Only).

From Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A theoretical analysis of the temperature and velocity distribution in symmetrical and asymmetrical triangular rod clusters is presented. The analysis is applied to Na coolant with fully developed turbulent flow. Coolant mixing is taken into account by correlations for the eddy diffusivities of momentum and energy. The thermal heat flux at the outer boundary of the fuel pin is variable in circumferential and axial direction. 7 references. (auth)

24820 (EURFNR-751) PARTLY INTEGRATED COOLING SYSTEM FOR LIQUID METAL COOLED REACTORS. Mueller, R. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Mar 1970. 14p. (KFK-1156; SM-130/42; CONF-700307-2). Dep. CFSTI (U. S. Sales Only).

From Symposium on Progress in Sodium-Cooled Fast Reactor Engineering, Monaco.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A partly integrated cooling system for liquid metal cooled reactors is described. The proposed system combines to a remarkable extent the advantages of the pool and loop systems generally discussed. In the new design only the reactor core and eventually an emergency cooling system is located in the reactor pool. The components of the primary circuit are installed in one or several stationary component pools which are connected with the reactor pool via straight coaxial conduits. To accommodate thermal expansion effects bellows and sliding sleeve-joints were used. However, these parts are arranged in such a way that they might be easily replaced and a possible leak will not result in a coolant leakage. Some design variants of the new partly integrated cooling system are discussed and a possible layout for a 1600 MW(e) plant is given. 2 references. (auth)

24821 (ORNL-4508, pp 113-58) PRESTRESSED-CONCRETE REACTOR PRESSURE VESSEL RESEARCH AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

CONCRETES—creep in, effects of strain and time on uniaxial, biaxial, and triaxial
—mechanical properties of, effects of temperature and temperature cycling on
PRESSURE VESSELS—development of high temperature gas cooled power reactor prestressed concrete

REACTORS, GAS-COOLED—pressure vessels for high temperature power, development of prestressed concrete
REACTORS, POWER—pressure vessels for high temperature gas cooled, development of prestressed concrete (D.C.C.)

24822 QA PUT TO WORK ON THE PCRV. Power Eng.; 74: 45-8(Mar 1970).

Construction requirements and techniques used for prestressed concrete pressure vessels are described. Material restrictions are reviewed. (D.C.C.)

24823 PERSPECTIVES FOR HEAVY WATER REACTORS IN THE DEVELOPMENT OF BREEDER-CONVERTER NUCLEAR POWER PLANTS. Fonteray, P. J. (CEA, Paris); Noel, R.; Thome, P.; Naudet, R. Technical Meeting No. 3/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

Several coolants have been contemplated for heavy water reactors. A comparison between these coolants is made where heavy water itself seems presently in the best position. Two concepts are possible (vessel or pressure tubes). For large reactors, the pressure tube system seems more advanced. (auth)

24824 BURNOUT TESTS IN THE SCOPE OF TECHNICAL SAFETY INVESTIGATIONS. Mayinger, F.; Hein, D.; Kastner, W. (Maschinenfabrik AG, Nuernberg). Technical Meeting No. 5/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

Burnout tests were made on four-rod and nine-rod clusters under the operating conditions prevailing in boiling water and pressurized water reactors to study the influence of radial heat flux distribution and the critical heat flux under conditions of power and mass flow transients. Radial flux distribution raises the question of an accurate subchannel analysis. During fast power transients the maximum heat flux is a function of the bundle geometry. All transient tests showed that critical heat fluxes are not lower under these conditions than those to be expected under corresponding quasi steady-state conditions. (auth)

24825 DESIGN AND OPERATION OF A BURNOUT DETECTOR WITH THYRISTOR. Pislar V.; Jovanovic, Lj. Bull. Boris Kidric Inst. Nucl. Sci., Nucl. Eng.; 20: No. 5, 29-32(Oct 1969).

The burnout detector is a safety device by which the power input to the experimental test element is cut off in the investigation of maximum heat flux. The burnout detector based on the principle of electrical resistance change of the experimental test element and using power thyristor and microrelay as the final components is described. In the moment of burnout, auxiliary resistance is connected by thyristor to one part of test element. So, the power of element is reduced to the safety value. At the same time, by a microrelay, the voltage of the main connector of the transformer-rectifier set is switched off. The choice of thyristor as the connecting element is justified because it requires a short time to reach the high conductivity region and the possibility of conducting the current of the order of kA in the time interval of several msec. This is an important characteristic of the thyristor as the burnout occurs in the order of about ten msec. (auth)

24826 NUCLEAR REACTOR INSTALLATIONS. Birch, William; Powell, Christopher (to United Kingdom Atomic Energy Authority). British Patent 1,185,881. 25 Mar 1970. Filed 29 Mar 1967.

Reference is made to nuclear reactors of the type wherein the fuel is housed in pressurized coolant conducting tubes which extend upwardly into a pond of water located above the reactor and into which irradiated fuel elements can be withdrawn. The system described comprised a pressurized coolant circuit which includes vertically disposed fuel tubes; the tubes have closable extensions for placing fuel into and out of them, and terminate in a structure containing a pond located above the reactor. The floor for the pond is formed by a flexible tube plate which is peripherally sealed to the wall of the structure and supported by the extensions, the latter providing evenly distributed support structs for the submerged flexible tube plate which can thus deflect, without causing leakage, in order to accommodate expansion of the tubes and extensions. In a steam generating installation there may conveniently be at least two pressurized water coolant circuits, each of which includes a group of fuel tubes with extensions, and the tube plate may be divided into flexibly interconnected sections sealed together by a flexible membrane or membranes, each section being supported by the extensions of one group of tubes. In the event of one circuit becoming depressurized the resultant differential thermal expansion of the circuits can be accommodated by deflection of one section relative to another. The pond should preferably be provided with a removable plug forming part of a primary containment structure for the reactor, the plug being sealable to the wall of the pond-containment structure so that the tube plate can be isolated from the pond water. A number of detailed variations are also described. (UK)

24827 OPTICAL REPRESENTATION OF THE BOILING OF SODIUM IN A MODEL OF A REACTOR COOLING PIPE. Spiller, K.-H.; Perschke, D.; Grass, G. (EURATOM, Ispra, Italy). Chem.-Ing.-Tech.; 42: 381-4(Mar 1970). (In German).

Sodium is boiled by high-frequency induction heating in a long, thin stainless steel tube which serves as a model of a reactor cooling pipe. The curve of temperature in the axis of the tube and the curve of velocity for the moving Na column are photographed on the screen of a double-beam oscillograph. The temperature of the outer skin of the tube, the onset of boiling on overheating, and the length of the resulting Na-vapour locks, are recorded on cine film at increased frame speeds. The film provides an instructive picture of the processes occurring in the simulated cooling pipe. 5 references. (auth)

24828 A STEAM GENERATOR. (to Siemens Aktiengesellschaft). British Patent 1,188,602. 22 Apr 1970. Priority date 25 Mar 1967, Germany.

BOILERS—tubes for pressurized water reactor, arrangement of helical strip spaced parallel
REACTORS, PRESSURIZED-WATER—boilers for, description of helical strip spaced parallel tubes in (D.C.C.)

24829 DRAG COEFFICIENTS FOR FUEL ELEMENT SPACER GRIDS. Rehme, K. (Institut fuer Neutronenphysik und Reaktortechnik, Karlsruhe, Ger.). Atomkernenergie; 15: 127-30(1970). (In German).

The results of pressure drop measurements with five different spacer grids in rod bundles are reported. The rod bundles consisted of 37 (169) rods arranged in a hexagonal array and contained in a prismatic hexagonal channel. The experimental results are correlated by introducing a modified drag coefficient. For preliminary core design calculations it is possible by means of this coefficient and of the flow restriction due to the spacer to predict the pressure loss across various spacer grids with good approximation. (auth)

24830 CRACK DEVELOPMENT IN A PRESTRESSED CONCRETE REACTOR VESSEL AS DETERMINED BY A LUMPED PARAMETER METHOD. Mohraz, Bijan (Univ. of Illinois, Urbana); Schnobrich, William C.; Gomez, A. Echeverria. Nucl. Eng. Design; 11: 286-94(Mar 1970).

A numerical method of analysis for the study of the behavior of prestressed concrete reactor pressure vessels both in the elastic and the cracking state using the "lumped parameter" model is presented. Displacements and strains obtained from example calculations are compared with experimentally determined values. (12 references) (auth)

24831 SEISMIC ANALYSIS OF PIPING SYSTEMS. Lin, Chiwen. (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design; 11: 217-24(Mar 1970).

Seismic analysis of piping systems is reviewed based on the single degree response spectrum curve technique and lumped mass parameters. Using the design of the primary coolant loop of a typical nuclear power plant as an example, both stiffness and flexibility formulations are discussed in detail, in which the pipes, valves, steam generator, and coolant pump are included in the three dimensional model. Since it is a general practice to choose only part of the six degrees-of-freedom in each concentrated mass, the flexibility matrix constructed based on this reduced system is not complete. Consequently, the usual approach of obtaining shear forces from a stiffness matrix may be in error when the latter has to be computed by inverting the reduced flexibility matrix. This difficulty can be overcome by reducing the stiffness matrix after inverting the complete flexibility matrix. However, this is not always practical because the size of the matrix, which has to be inverted, may be large. On the other hand, whether the use of stiffness matrix together with the maximum relative displacement vector will give a maximum reverse effective force vector is uncertain. Consequently, the stiffness method may not always yield satisfactory results. In the light of these difficulties, to compute an approximate but conservative absolute acceleration vector becomes more attractive in the sense that this process does not require inverting any matrix. The reverse effective force vector obtained by multiplying the diagonal mass matrix with the maximum absolute acceleration vector will, indeed, be a maximum. (6 references) (auth)

Fuels

Refer also to abstracts 23537 and 24854.

24832 (AEEW-R-655) BURN-OUT POWER AND PRESSURE DROP MEASUREMENTS ON 12-FT. 7-ROD CLUSTERS COOLED BY FREON-12 AT 155 PSIA. Heron, R. A.; Kinneir, J. H.; Stevens, G. F.; Wood, R. W. (Atomic Energy Establishment, Winfrith (England)). Sep 1969. 36p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

Burn-out power and pressure drop measurements are reported for six 7-rod clusters of 12 ft. heated length, cooled by Freon-12 at 155 psia in vertical up-flow. The clusters had the same rod diameter and shroud tube bore, but the pitch circle of the ring of rods was varied from the smallest possible diameter to the largest possible diameter. All the clusters thus had the same value of equivalent diameter based upon a ratio of flow area to heated perimeter, and the results of the experiments provide a critical test of the validity of this concept. Both pressure drop and burn-out power were found to vary significantly with change of pitch circle diameter showing that the concept is an inadequate representation of a rod cluster in boiling heat transfer. 7 references. (auth)

24833 (BNWL-1324) CALCULATIONS OF BURNUP AND DAMAGE FOR FAST REACTOR FUELS. Dahl, R. E. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 24p. Dep. CFSTI.

A method has been developed for relating burnup in fast reactor fuels to the damage sustained by the cladding. Traditionally, data on structural materials irradiation tests are reported in units of fluence while fuels irradiation data and design requirements are in terms of burnup. The relationship between these systems must be determined so that the properties of the cladding can be predicted accurately for LMFBR fuels. These analyses show that the cladding to burnup ratio depends in a complex manner upon the initial fuel composition, the neutron spectrum, and the duration of the irradiation. Moreover, the conditions in an LMFBR cannot be duplicated in any test reactor. Therefore, analyses are required in both the application of test irradiation data to LMFBR fuel design and in the selection of irradiation facilities. Problems on the loss of pin power during extended irradiations and uncertainties in conventional burnup measurements are discussed. (6 references) (auth)

24834 (ORNL-4508) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1969. Savolainen, Ann W. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 163p. Dep. CFSTI.

Information concerning the development of high-temperature gas-cooled reactors is presented. General topics discussed include: high-temperature gas-cooled reactor development; gas-cooled fast reactor development; and prestressed-concrete reactor pressure vessel research and development. Separate abstracts are included for each of the 3 sections presented. (D.C.C.)

For abstracts of individual sections see: 24821, 24835, and 24836.

24835 (ORNL-4508, pp 3-70) FUEL ELEMENT DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

BOILERS—welds in high temperature gas cooled reactor steam generators, corrosion resistance of nickel alloy
CARBON—radiation effects on pyrolytic coatings of, fast neutron
FISSION PRODUCTS—release from high burnup coated particle fuels, effects of temperature on
GRAPHITE—oxidation by steam, (T)
NEUTRONS, FAST—effects on pyrolytic carbon coatings
NICKEL ALLOYS—corrosion resistance in steam generator welds
RADIATION TARGET CANS—design of instrumented, for bonded bed coated particle fuel irradiation
REACTOR FUELS—radiation effects on stability of bonded bed coated particle, fast neutron
—failure of coated particles in bonded beds at high temperatures
REACTORS, GAS-COOLED—fuel elements for high temperature power, development and irradiation testing of
—fuels for high temperature, irradiation testing of bonded bed coated particle
REACTORS, POWER—fuel elements for gas cooled high temperature, development and irradiation testing of
STEAM—oxidation of graphite by, (T)
THORIUM OXIDES ThO_2—radiation testing of bonded bed coated particles
URANIUM CARBIDES—radiation testing of bonded bed coated particles
URANIUM OXIDES UO_2—radiation testing of bonded bed coated particles
WELDS—corrosion resistance in steam generators of nickel alloy (D.C.C.)

24836 (ORNL-4508, pp 71-112) GAS-COOLED FAST REACTOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

NEUTRONS, FAST—effects on physical properties of plutonium oxide (PuO_2)-uranium oxide (UO_2) and uranium oxide (UO_2) pellet type fuel elements
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation effects on physical properties of pellet shaped, fast neutron
REACTOR FUEL ELEMENTS—heat transfer characteristics of gas cooled, effects of accident conditions on
—radiation effects on physical properties of plutonium oxide (PuO_2)-uranium oxide (UO_2) and uranium oxide (UO_2) pellet type, fast neutron
REACTORS, FAST—fuel elements for gas cooled power, irradiation testing of plutonium oxide (PuO_2)-uranium oxide (UO_2) and uranium oxide (UO_2) pellet type
REACTORS, GAS-COOLED—fuel elements for fast power, irradiation testing of plutonium oxide (PuO_2)-uranium oxide (UO_2) and uranium oxide (UO_2) pellet type
REACTORS, POWER—fuel elements for gas cooled fast, irradiation testing of plutonium oxide (PuO_2)-uranium oxide (UO_2) and uranium oxide (UO_2) pellet type
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation effects on physical properties of pellet shaped, fast neutron
—radiation effects on physical properties of plutonium oxide (PuO_2)-uranium oxide (UO_2) and uranium oxide (UO_2) pellet type, fast neutron

24837 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Packman, Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,184,188. 11 Mar 1970. Filed 21 Oct 1966.

Reference is made to a power reactor having forced coolant flow. Improvements in heat removal from the fuel elements of power reactors where the coolant flows upwardly over the fuel elements has been at the expense of increasing the levitation problem, that is, the tendency for reactor components such as fuel elements to be lifted. The system described is based on using a coolant pressure difference to resist levitation. A nuclear fuel stringer is employed having two components in axial juxta position in the direction of the reactor fuel channel axis. These two components are capable of being telescoped together, one into a space having an axial boundary and an inner peripheral boundary provided by the other; a sliding seal between the two components seals against leakage along the peripheral boundary, and another sliding seal on the component downstream in the fuel channel seals against leakage between this component and the channel wall. The space can contain coolant at a higher pressure than prevails elsewhere in the fuel channel, introduced from between the upstream component and the channel wall. In a gas cooled reactor of the AGR type this higher pressure coolant can be the re-entrant coolant, which is about 2 lb./sq. in. in excess of the pressure at the fuel channel inlet and which can yield a force of 80 lb. or so. A nuclear reactor utilizing such fuel stringers and arranged to supply such higher pressure coolant is described. (UK)

24838 IMPROVEMENTS IN OR RELATING TO MEANS FOR COUPLING TUBULAR MEMBERS. Anderton, Cyril; Packman, Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,184,435. 18 Mar 1970. Filed 1 Sep 1966.

Reference is made to means for coupling the sub-assemblies of nuclear reactor fuel elements, and in particular those of the cluster type used in advanced gas-cooled reactors, which comprise two main parts, the fuel part and the shield-and-plug part. The coupling described comprises two cylindrical tubular members and a cylindrical sleeve which is captive on one end of one of the tubular members in such a manner as to permit rotation of the sleeve about that member but to prevent axial movement. The sleeve and the other tubular member have spaced lugs arranged so that these parts can be moved axially and rotationally relative to each other to engage the lugs one behind another to provide the tensile-load-bearing connection and provide releasable locking means for preventing rotation of the sleeve relative to the other member when connection has been established. The locking means may comprise spring fingers. The lugs may project inwardly and the sleeve may have recesses for engagement by a tool for rotating it. The free ends of the spring fingers may have pads which project into the recesses

so that, with the coupling engaged, they may be deflected by engagement of the tool to clear the lugs on the sleeve and thereby enable rotational movement of the sleeve relative to the other member. (UK)

24839 THE INFLUENCE OF URANIUM SUPPLY ECONOMICS ON THE PLUTONIUM UTILIZATION DECISION. Burpee, Laurence D. Technical Meeting No. 2/1 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).
See CONF-691018.

If major U consumers are willing to conclude supply contracts of a kind that will maintain the tempo of exploration and development established over the past 3 years, they can be confident that ample new U supplies will be available during the next decade at prices in current terms of less than U. S. $10 per lb. U_3O_8. The emerging U industry is analyzed and against this background, the factors which will influence the reactor operator's Pu utilization decisions are considered. It is concluded that the U supply situation will not be a factor encouraging recycle. (auth)

24840 THE UTILIZATION OF PLUTONIUM AS AN ALTERNATIVE FUEL IN BOILING WATER REACTORS. Fischer, D.; Gournelos, D.; Judson, B. Technical Meeting No. 2/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).
See CONF-691018.

The technical feasibility of utilizing Pu in boiling water reactors is being established in a number of demonstration programs in operating reactors. The fuel concepts incorporated in these programs include considerable breadth in terms of distribution of Pu within the fuel assemblies and the fabrication concept employed. The scope of these Pu utilization programs is reviewed, and important technical factors in utilizing Pu in boiling water reactors are discussed. Several alternate concepts for utilizing Pu boiling water reactors are described. These include variations in the number of rods in an assembly containing Pu, utilization of annular pellets, and incorporation of combinations of plutonium and burnable poisons in a fuel design. The need is stressed for a flexible design approach which can accommodate variations in important economic parameters at the time of a specific application of Pu in a particular reactor. (auth)

24841 RELATIVE FUEL CYCLE PERFORMANCE POTENTIAL OF SODIUM AND GAS COOLED FAST BREEDER REACTORS. A COMPARATIVE EVALUATION BASED ON THE USE OF STAINLESS STEEL CLAD FUEL PINS. Behrenz, P. (AB ASEA-ATOM, Vasteras, Sweden); Hannerz, K.; Oppegaard, K.; Persson, P.; Poern, K.; Unneberg, L.; Vieider, G. Technical Meeting No. 4/9 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).
See CONF-691018.

The results of a systematic comparison indicate that the cladding temperature dependency of oxide fuel pin burnup capability in the 650–800°C range will be quite important. If this dependency is weak, gas cooling appears to be very promising. If, on the other hand, the attainable burnup drops off sharply with temperature, due to cladding property deterioration, the outlook for the gas cooled breeder with stainless steel clad fuel pins appears much less favorable. It is concluded that further exploratory irradiations of cladding materials and fuel pins in the upper part of the above temperature interval should precede a final assessment. (auth)

24842 EFFECTS OF CLADDING THICKNESS AND THERMAL CONDUCTIVITY ON HEAT TRANSFER TO LIQUID METALS FLOWING IN-LINE THROUGH BUNDLES OF CLOSELY SPACED REACTOR FUEL RODS. Dwyer, O. E.; Berry, H. C. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 40: 317-30 (May 1970).

The results of an analytical study carried out for the purpose of determining the effects of cladding thickness and conductivity on fully developed heat transfer to liquid metals flowing in-line through unbaffled rod bundles are presented. The study is based on slug flow and the assumption that the heat flux on the inner wall of the cladding is uniform in all directions. It was shown earlier that slug-flow results for liquid metals are very similar to those for turbulent flow in practical Pe ranges, particularly when the results are put in certain dimensionless forms, and it is shown in the present study that the assumption of circumferentially uniform heat flux on the inner wall of the cladding is perfectly valid for any practical nuclear-reactor design for a central-station power plant. The problem required the simultaneous solution of the differential energy equations for both the coolant and cladding, which are coupled by the local temperature and heat-flux conditions existing at the coolant-cladding interface. There are three prime independent variables: rod spacing (P/D), relative cladding thickness $(r_3-r_1)/r_2$, and relative cladding conductivity (k_w/k_f). These have been varied over the ranges 1.05 to 1.30, 0.025 to 0.300, and 0.10 to 4.00, respectively. The following quantities have been calculated as functions of the above independent variables: rod-average heat transfer coefficients, circumferential variation of outer-surface cladding temperature, the same for the inner surface, circumferential variation of local heat flux, and finally, circumferential variation of local heat-transfer coefficient. The results are all expressed in the form of convenient dimensionless groups and are correlated by simple mathematical expressions, for ready use by the design engineer. It is found that, of the three prime independent variables, the P/D ratio has by far the greatest influence on the heat transfer behavior of the system; and that, of the remaining two variables, the thermal conductivity ratio, k_w/k_f, has appreciably more influence than the relative-cladding-thickness ratio $(r_3-r_1)/r_2$. The higher the P/D ratio and the lower the $(r_3-r_1)/r_2$ and k_w/k_f ratios, the more the system behaves like the uniform-wall-heat-flux case; and it is interesting to note that in many practical situations the simple uniform-wall-heat-flux assumption is quite adequate. (auth)

24843 SPACERS FOR FUEL ASSEMBLIES. Aoki, Shigeo; Kobayashi, Yukio (Furukawa Electric Co., Tokyo). FAPIG (Tokyo); No. 51, 186-96(Nov 1968). (In Japanese).

The development of spacers is discussed. The role of spacers, the precise holding of fuel rods, the reduction in the flow area of coolant, the requirement for spacer material, and the ease of spacer fabrication are discussed. Spacers for the Japan Power Demonstration Reactor (JPDR) are plate-type spacer, wire spacer, flexible-wire spacer, bellows-type spacer, and heart-type spacer. Spacers for the Advanced Thermal Reactor (ATR) are wire-wrapping spacer and grid-type spacer. The spacer for the Fast Breeder Reactor (FBR) is a pipe-type grid spacer. (NSA of Japan)

24844 NUCLEAR REACTORS. Martin, Dudley James Victor (to United Kingdom Atomic Energy Authority). British Patent 1,185,780. 25 Mar 1970. Filed 29 Mar 1968.

Reference is made to reactors of the kind wherein the fuel consists mainly of natural or slightly enriched U, together with some richer fuel. By varying the position of the richer fuel the reactor reactivity coefficient may be varied. Some neutron absorbing material may be included with variable positions within the reactor channel to control reactivity. Means are described to effect movements of the fuel or other material. Two assemblies are reciprocable within the reactor channel by a drive mechanism located outside one end of the channel, and these assemblies and the drive mechanism are connected end-to-end in series by releasable couplings; means are provided for selectively releasing the couplings within the channel to enable withdrawal of one or both members from the other end of the channel. One or both assemblies may be withdrawn without disturbing the drive mechanism. The releasable couplings may comprise ball latches, and the means for releasing the couplings may comprise a bar extending between the latches and arranged so that in one position the balls are held in engagement with the latching members. The bar is axially moveable to second and third positions wherein the balls are released so that either both members are unlatched from the drive mechanism or the members are unlatched from each other. (UK)

24845 VENTED FUEL ELEMENT. (to U. S. Atomic Energy Commission) British Patent 1,188,276. 15 Apr 1970. Priority date 24 Jul 1968, United States.

FISSION PRODUCTS—venting of gaseous, description in fuel elements of system for
REACTOR FUEL ELEMENTS—vent system for liquid metal cooled, description of fission gas
REACTORS, LIQUID METAL-COOLED—fuel elements of, description of fission gas vent system for (D.C.C.)

24846 IMPROVEMENTS RELATING TO NUCLEAR REACTOR. (to Combustion Engineering, Inc.). British Patent 1,188,086. 15 Apr 1970. Priority date 14 Apr 1967, United States.

REACTOR FUEL ELEMENTS—cooling of pressurized water, description of core arrangement for optimum
—power density of pressurized water, description of core arrangement for optimum
REACTORS, PRESSURIZED WATER—fuel elements of, description of core arrangement for optimum cooling and power density in (D.C.C.)

Operation and Economics

Refer also to abstract 24839.

24847 (AECL-3553) OUTLOOK FOR CANDU REACTORS. PART I. TECHNICAL. PART II. ECONOMIC. Hurst, D. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jan 1970. 23p. (CONF-690948-1). Dep. CFSTI (U. S. Sales Only). AECL $1.00.

From International Survey Course on Economic and Technical Aspects of Nuclear Power Conference, Vienna, Austria.

The CANDU reactor system, established at NPD and Douglas Point, is the basis for two of the world's large nuclear generating stations, Pickering and Bruce, which are now under construction. Further evolution of the system will result from materials development, fuel modifications, and higher thermodynamic efficiency, but with firm guidance by cost evaluations that are kept fully up-to-date. Significant reduction of capital cost should be attainable without seriously affecting the already low fuelling cost. (8 references) (auth)

24848 (EUR-4407) THE POSSIBILITIES OF INCORPORATING NUCLEAR POWER PLANTS IN THE WEST GERMAN ELECTRICITY SUPPLY SYSTEM BY 1985. With Special Reference to the Regional Electricity Generation Conditions. Final Report. (Deutsches Institut fuer Wirtschaftsforschung, Berlin (West Germany)). 9 Jun 1969. 138p. (In German). Dep. CFSTI (U. S. Sales Only). EUR DM 13,55.

The economic and technical possibilities of installing light water nuclear power stations in Western Germany between now and 1985 are evaluated. The lowest production costs would in most regions be reached with light water nuclear power stations having a capacity of 600 MW(e). (auth)

24849 PLUTONIUM RECYCLE IN THERMAL REACTORS. Conti, F.; Graziani, G.; Rinaldini, C.; Zanantoni, C. (EURATOM-CCR, Ispra, Italy). Technical Meeting No. 2/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The value of Pu in thermal reactors is assessed with the indifference method, that is comparing the best use of Pu and ^{235}U in a system where only one type of reactor is available. In order to compare different Pu qualities, the Pu value is expressed as a linear function of the values of each single isotope. The work reported concerns light water reactors, heavy water reactors and high temperature reactors, both with U and (for the last two) Th cycle. The calculation method, that is the fuel cycle physics and economics, and the several types of fuel cycles which have been compared, is briefly described. The Pu values are reported and a few general considerations about its use in the various types of reactors are made. (auth)

24850 BRITISH VIEW ON PLUTONIUM UTILISATION. Kronberger, Hans (United Kingdom Atomic Energy Authority, London). Technical Meeting No. 2/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The production and use of Pu as a nuclear fuel in various reactor systems are reviewed. Considerable quantities of Pu will arise from the early British nuclear power program. A full economic assessment of the UK system shows that Britain should plan to store this Pu for use in fast reactors due to come on power in later years. This results in a substantial reduction in U requirements compared to recycling Pu in thermal reactors only. The value of Pu and the experimental investigation to determine its nuclear characteristics are discussed together with the development and manufacture of Pu fuels. (auth)

24851 PREPARING FOR COMMERCIAL PLUTONIUM RECYCLE. Bonanni, M.; Cotton, J. D.; Roll, J. B.; Hoffmeister, A. J. (Westinghouse Electric Corp., Geneva). Technical Meeting No. 2/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The basis, the elements, and the progress of a program consisting of tasks to enable the design and fabrication of Pu fuel and to provide an economical commercial Pu fuel cycle are discussed. The economic utilization of Pu will be demonstrated through the design, manufacture and operation of large quantities of Pu, first in Recycle Demonstration Programs, then by the commercial sale and utilization of Pu fuel. (auth)

24852 BELGONUCLEAIRE'S TEN YEAR PROGRAMME IN PLUTONIUM RECYCLING. Fossoul, E.; Vanden Bemden, E. (Belgonucleaire S. A., Brussels). Technical Meeting No. 2/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

A brief summary of the work performed since 1960 in the field of Pu recycling in thermal reactors is presented. This work, carried out in the frame of an association between Belgonucléaire and the Centre d'Etude de l'Energie Nucléaire (C.E.N.), comprises: research work on nuclear fuel fabrication techniques supported by irradiation behavior experiments in material testing and power reactors; and theoretical and experimental studies on the development of calculation methods for light water reactor cores loaded with Pu. (auth)

24853 PLUTONIUM: AN ALTERNATE FUEL FOR THERMAL POWER REACTORS. Wolff, U. (AEG-Telefunken, Frankfurt am Main). Technical Meeting No. 2/7 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

Technically, Pu is an adequate alternative fuel for thermal power reactors. An economically rational recycling of Pu into thermal reactors is likely to become realized from 1975 onward. The problems, feasibilities, and current development programs involved are described. (auth)

24854 PROBLEM OF THE FABRICATION AND USE OF Pu-BEARING FUEL ELEMENTS. Schneider, V. W. Technical Meeting No. 2/9 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Looking at the growth of the Pu-market, a recycling into thermal reactors seems to be reasonable. The results of first studies of calculation of Pu-bearing elements are to a certain extent helpful to reduce the production costs, but further work in this direction has to be done. ALKEM's activities up to now in the field of Pu-recycling into thermal reactors are briefly described and an automatic production line under construction is presented. (auth)

24855 THE CONSTRUCTION, COMMISSIONING, AND OPERATION OF THE WINFRITH STEAM GENERATING HEAVY WATER REACTOR. Cartwright, H.; McKeague, R.; Smith, D. (United Kingdom Atomic Energy Authority, Risley, Eng.). Technical Meeting No. 3/3 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

The experience of the construction, commissioning, and operation of the Winfrith Steam Generating Heavy Water Reactor over the first eighteen months of power operation is described. Overall plant availabilities are given and the performance of important plant components is described. The relevance of the prototype experience to large commercial reactors is emphasized. (auth)

24856 PRESSURIZED WATER REACTORS WITH NATURAL URANIUM- AND THORIUM-FUEL CYCLES. Strueger, Rudolf (Siemens AG., Erlangen, Ger.). Technical Meeting No. 3/5 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

Among natural U reactors, the heavy water-type is economically feasible and competitive, especially in countries without enrichment facilities. Operational experiences are reported. Leakage problems in the cooling system and their avoidance are discussed. Also considered are the protection systems, especially the emergency cooling system. Properties of pressurized heavy water and light water reactors are compared as to fuel requirement, cooling system, steam condition, and efficiency. Due to its high Pu production rate, heavy-water–natural U reactors could possibly be used in combination with heavy-water–Th converters. (H.B.G.)

24857 FAST BREEDER REACTORS: ECONOMIC AND TECHNICAL PROSPECTS AND ACTUAL STANDING OF DIFFERENT DESIGNS, ESPECIALLY WITH RESPECT TO THE COOLANT. Ernst, R. (Siemens AG, Munich); Guthmann, E.; Fischer, J.; Seetzen, J. Technical Meeting No. 4/4 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6–11, 1969. Basel; NUCLEX 69 (1970). (In German).

See CONF-691018.

Historical, technical, and economic analyses lead to the fol-

lowing conclusion about fast breeder reactors: on a global scale, Na-cooled types are highest in development and widest in distribution. If no unexpected problems arise, these reactors will be in industrial use after 1980. Their economics will be especially favorable after introduction of carbide fuel elements. Steam-cooled types have been abandoned, or at least postponed, by all countries. He fast breeders have certain attractive characteristics but at present little developmental work is being performed. Specifications for the SNR prototype Na-cooled breeder reactor, to be built in Aachen, Germany, are tabulated. (H.B.G.)

24858 ECONOMICS OF ADVANCED THERMAL REACTOR. Oshima, Keiichi (Tokyo Univ.). Genshiryoku Kogyo; 16: No. 2, 16-20(Feb 1970). (In Japanese).

The development of an advanced thermal reactor, in parallel with a fast breeder reactor, is in progress in Japan. The ATR is D_2O moderated and boiling light-water cooled. The initial fuel is slightly-enriched U, and subsequently the operation is maintained only by natural U with enriched Pu. The economy of an ATR has been studied with emphasis on the following: the economic prospect of an ATR compared with ordinary light-water reactors, the efficient use of nuclear fuel, and the technical feasibility of an ATR. In comparison with a light-water reactor, the case of a 500 MW(e) power station is examined in terms of construction cost, technical advance, fuel-cycle cost, and D_2O cost. The cost of power by an ATR is found to be equal to or less than that by a light-water reactor. As the economic features of an ATR, the adaptability to fuel-cost change, the prospect for reactor export, etc. are also considered. (NSA of Japan)

24859 COST DEGRESSION IN INTEGRATED NUCLEAR ENERGY PLANTS (TREND ANALYSIS). Franke, F. H.; Femmer, U. (Technische Hochschule, Aachen). Atomkernenergie; 15: 138-40(1970). (In German).

With the aim of reducing the costs in integrated nuclear energy plants to a minimum, the trend in the lowering of the relative costs of gas-cooled prototype and commercial nuclear reactors has been investigated. A reactor capacity of approximately 3000 MW, which can be regarded as economically favourable, is represented by a plant of a capacity greatly superior to that of the conventional capacity 300 to 600 MW from a single plant. (auth)

Safety and Siting

24860 (DOCKET-50231-45) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Proposed Change No. 1. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 17 Apr 1970. 20p. Dep. CFSTI.

The installation of thermocouples in the reflector region of the reactor is described. (D.C.C.)

24861 (NP-18198) FINITE ELEMENT ANALYSIS OF STRUCTURAL INTEGRITY OF A REACTOR PRESSURE VESSEL DURING EMERGENCY CORE COOLING. Ayres, D. J.; Siddall, W. F. (Combustion Engineering, Inc., Windsor, Conn.). Jan 1970. 54p. (A-70-19-2).

The finite element method is used to compute the stress near the tip of hypothetical axial and circumferential cracks in a nuclear reactor vessel. The stress intensity factor as a function of crack depth is computed for thermal, pressure and residual stress loadings. In order to estimate the accuracy of the finite element solution, the stress intensity factor as a function of crack depth is computed for a single edge cracked tensile specimen. The results were compared to a boundary collocation solution and found to be in good agreement. The stress intensity factors caused by thermal stress computed by the finite element method are in close agreement with the Irwin closed form solution for shallow cracks. For deep circumferential cracks, the Irwin solution is found to be substantially conservative. For deep axial cracks, a modification of the Irwin solution is also found to give conservative results. The difference between the computed reactor vessel toughness requirements and the extrapolated irradiated toughness indicates that cracks in the vessel will not grow during the thermal shock transient associated with emergency core cooling operation. 11 references. (auth)

24862 SEISMIC ANALYSIS OF EQUIPMENT MOUNTED ON A MASSIVE STRUCTURE. Biggs, J. M.; Roesset, J. M. (Massachusetts Inst. of Tech., Cambridge). pp 319-43 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

A method of seismic analysis for equipment and piping located in and supported by large structures is presented. It is assumed that a modal analysis of the structure has been made using the response spectrum method. The seismic input has been given in terms of a ground motion response spectrum. The result of the structural analysis is therefore the maximum modal acceleration at any point on the structure including the point at which the item of equipment is attached. (auth)

24863 MODAL RESPONSE OF CONTAINMENT STRUCTURES. Pahl, Peter Jan (Massachusetts Inst. of Tech., Cambridge). pp 344-400 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

Some of the considerations which enter into the determination of the modal response of a containment structure are analyzed. The most demanding phase of this analysis is the selection of an adequate mathematical model representing the structure, its contents and particularly its foundation. In selecting a computational algorithm for the solution of the algebraic eigenvalue problem for the mathematical model, the likely nature of the results should be considered. Some of the considerations are illustrated with an example. 12 references. (auth)

24864 PROVISION OF REQUIRED SEISMIC RESISTANCE. Holley, M. J. Jr. (Massachusetts Inst. of Tech., Cambridge). pp 401-37 of Seismic Design for Nuclear Power Plants. /Hansen, Robert J. (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

Seismic stress limitations in the design of reactor buildings and containment structures are analyzed. Topics discussed include: plate steel containment shells; liner integrity in relation to containment failure; relative magnitude of containment membrane stresses due to earthquake; prestressed reinforcement in relation to earthquake membrane stresses; multi-directional rebars to resist multiple two-dimensional stress states; axially stressed rebar quantities for membrane stress equilibrium; membrane shear resistance for two-directional rebar arrangements; and dowel action. (D.C.C.)

24865 GENERAL VIEWS AND ACTUAL TRENDS OF REACTOR SAFETY IN FRANCE. Bourgeois; Stolz; Bebin; Nifenecker; Panossian; Rieul. Technical Meeting No. 5/2 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970). (In French).

See CONF-691018.

The three principal barriers to the release of radioactive products from a nuclear reactor are defined and discussed from the point of view of reactor type. Protection of the integrity of fuel element cladding, protection of the primary circuit, and protection of the containment structure are examined for graphite-gas, sodium-cooled, and water-cooled reactors. Appendices discuss safety aspects of various reactor components and systems. (H.D.R.)

24866 SAFETY FEATURES IN ASEA-ATOM NUCLEAR POWER PLANT DESIGNS. Isberg, P. (ASEA-ATOM, Vasteras, Sweden). Technical Meeting No. 5/6 of NUCLEX 69: 2nd International Fair and Technical Meetings for Nuclear Industries, Basel, Switzerland, October 6-11, 1969. Basel; NUCLEX 69 (1970).

See CONF-691018.

Selected engineered safeguard features of ASEA-ATOM nuclear plant designs are described with emphasis on containment vessels. Views are given on the development of safety criteria. (auth)

24867 PROPOSALS FOR THE DESIGN OF REACTOR PROTECTION SYSTEMS. Schruefer, E. (AEG-Telefunken, Frankfurt am Main). Atomwirt., Atomtech.; 15: 185-8(Apr 1970). (In German).

For reactors, distinction must be made between the operation system and the protection system. The operation system should be completely independent of the protection system. In addition, the latter must be redundant in such a way that it will operate even if one of its components fails; that protective actions will not be triggered in the case of failure of one device; and that all components can be easily examined and tested. Examples are given for the separation of operation and protection systems as well as for the redundancy in the design of the protection system. Finally, probability consideration for component failures is presented, and occurrence of deterministic errors is discussed. (H.B.G.)

24868 INTERMEDIATE REPORT ON THE EARTHQUAKE RESISTANCE OF AGR CORE AND CONCRETE PRESSURE VESSEL. FAPIG (Tokyo); No. 51, 146-53(Nov 1968). (In Japanese).

The earthquake resistance of the reactor core and the prestressed concrete vessel of an advanced gas-cooled reactor was

studied. These studies are necessary because of the frequent earthquakes in the country and of the inexperience in the construction of PCPVs. The results obtained are described on the following: the earthquake load in a reactor core, the strength test on graphite blocks, the development of the procedure of PCPV elastic stress analysis, and the behavior of a PCPV in earthquake. The core structure of an AGR, although considerably different from that of a gas-cooled reactor such as in the Tokai Power Station, was proved to have high earthquake resistance. In the earthquake load of a reactor core, the load distribution due to quake waves from an external binding cylinder, as well as the quake behavior, is analyzed by means of a computer. The procedure of PCPV stress analysis by the finite element method gives good results for an AGR. (NSA of Japan)

24869 STUDIES ON THE SAFETY OF AN ADVANCED GAS-COOLED REACTOR (AGR). Ogushi, Kozo (Fuji Electric Co., Tokyo). FAPIG (Tokyo); No. 52, 231-5(Feb 1969). (In Japanese).

The safety of an AGR with about 500 MW(e) output was studied with a mockup of $1/10$ scale, simulating the damage at the penetration of a pressure vessel, the failure of blower's power source, and the entry of air into the gas system. A computer code was prepared for evaluating the accidents. By comparison with the experimental data, the values calculated by the code were found to be conservative. Further, the calculated values showed that the accidents in an AGR could be suppressed sufficiently. Other information obtained from the experiment and calculation is: (1) A smaller penetration through a pressure vessel is better in respect of the pressure reduction in loss-of-coolant accident. It is up to about 250 mm for a 500 MW(e) AGR. (2) The small penetration is desirable also in view of the channel flow-rate unbalance in penetration rupture. (3) It is advisable to install a plurality of separation valves in a purification bypass system. In the rupture of the system, at least one valve is closed, which is useful in respect of air entry and pressure reduction. (4) The influence of the reduction in the number of operating blowers is larger than that of the reduction in pressure in the heat removal from channels. (NSA of Japan)

24870 STRUCTURAL ANALYSIS OF AIRCRAFT IMPACT ON A NUCLEAR CONTAINMENT VESSEL AND ASSOCIATED STRUCTURES. Yang, H. T. Y.; Godfrey, D. A. (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design; 11: 295-307 (Mar 1970).

A consistent mass finite element approach for slab vibration analysis which is not limited to the simply-supported boundary conditions and can thus be employed to find more actual maximum responses of rectangular associated buildings; a finite element plate bending analysis for slabs with arbitrary boundary conditions for practical design purposes; and a numerical method of solution which combines the advantage of both the direct integration and the finite difference approach for static and vibration analysis of rotationally symmetric shells subject to non-symmetric loads are described. (13 references) (auth)

24871 BRUCH-D: A DIGITAL PROGRAM FOR PRESSURIZED WATER REACTOR BLOWDOWN INVESTIGATIONS. Karwat, H.; Wolfert, K. (Technische Hochschule, Munich). Nucl. Eng. Design; 11: 241-54(Mar 1970).

The PWR version of the computer code BRUCH is described. Special consideration has been given to the correct formulation of the necessary coolant properties—the specific volume of subcooled water and its derivatives with respect to pressure and enthalpy. Application of BRUCH-D to the blowdown of a pressurized water reactor is shown and the influence of different parameters on the results of the blowdown calculations is discussed. The pressure time history of a semiscale LOFT blowdown has been recalculated based on available information about the experiment. (10 references) (auth)

24872 SAFETY CONSIDERATIONS IN THE DESIGN OF SODIUM-COOLED REACTORS (RSR). Knecht, O. (Interatom GmbH, Bensberg, Ger.). Brennst.-Waerme-Kraft; 22: 119-23(Mar 1970). (In German).

From the point of technical safety, fast reactors take a special place amongst nuclear reactors, since over-critical energy release damages the reactor core itself, and this, in turn, can give rise to secondary energy release. It is, therefore, necessary to reduce the probability of these disturbances by suitable safety devices to the point that the resulting expectation of damage, i. e., the product of probability and effect, is smaller than or equal to the expectation of damage for other disturbances. The disturbance analysis, which includes the determination of the disturbance probability, is demonstrated with the aid of an example. (auth)

Research and Test Reactors

Refer also to abstracts 23014, 23504, 23534, and 24781.

24873 (AAEC/TM-508) METHOD OF ESTIMATING FUEL BURN-UP AND HIGHER ISOTOPE PRODUCTION IN THE REACTOR HIFAR. McCulloch, D. B.; Trimble, G. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1969. 17p. Dep. CFSTI (U. S. Sales Only).

Simple equations have been set up to calculate fuel burn-up and higher isotope production for the HIFAR reactor, with adequate accuracy for operational management and fuel accounting purposes. Recommended nuclear data are given for use in these equations. A programme, HIBURN, has been written to carry out the calculations routinely on an IBM 360/50 computer. (auth) (Australia)

24874 (AAEC/TM-509) BURN-UP STUDIES OF HIFAR MARK IV HOLLOW FUEL ELEMENTS. Culley, D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1969. 22p. Dep. CFSTI (U. S. Sales Only).

Multigroup neutron transport calculations in four and 30 groups have been performed on a Mark IV fuel element cell for the reactor HIFAR using the code WDSN. Details of the energy spectrum and fine flux structure within the element have been obtained. Variation of fine flux factors with burn-up is small enough to permit adoption of constant values for practical fuel management. A library of nuclear data, obtained from the code GYMEA, has been set up for further calculations. 4 references. (auth) (Australia)

24875 (BNWL-1286) METAL SWELLING EFFECTS ON FTR CORE COMPONENTS. Jackson, R. J.; Wheeler, C. L.; Waymire, G. R.; Little, W. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1970. Contract AT(45-1)-1830. 67p. Dep. CFSTI.

An elastic analysis which considered neutron-induced metal swelling was performed on each typical component in the Fast Test Reactor (FTR) core. The dilatation and duct bending resulting from the swelling and the swelling gradients are predicted for each component. Component interactions resulting from these dimensional changes are predicted, and duct-to-duct contact between supports during operation is proposed as a potential burnup limitation. Other potential burnup limitations from refueling considerations are discussed. (auth)

24876 (EURFNR-746) SNEAK-4: A SERIES OF PHYSICS EXPERIMENTS FOR KNK-II. Engelmann, P. (comp.) (Kernforschungszentrum, Karlsruhe (West Germany)). Oct 1969. 62p. (EUR-4303; KFK-1022). Dep. CFSTI (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Neutron physics experiments performed at SNEAK for the investigation of some nuclear properties of the KNK-II reactor are described. The results of the measurements on SNEAK assemblies 4A and 4B are reported and compared with calculations. The experimental results of critical mass and reactivities, control rod worths, Doppler coefficient, and power distribution were used to draw conclusions for the KNK-II design. 33 references. (auth)

24877 (INR-P-1150) SOME BASIC STATIC PARAMETERS FOR WWR-SM LATTICE. Yuzefovich, E. T. (Joint Institute of Nuclear Research, Warsaw (Poland)). 1969. 26p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The methods and results of measurements and calculations of the static parameters in the cores with multitube enriched fuel for WWR-SM type water moderated reactors are described. They include the thermal flux microdistributions, epithermal cell parameters δ^{25}, ρ^{28} and initial conversion ratio as well as critical buckling. An attempt at estimating the neutron age using simple calculations and taking advantage of numerous published experimental and calculational data on neutron age in Al–H_2O mixtures is presented. The interpretation of the results in the frames of infinite multiplication factor and two-group equation is given. 25 references. (auth)

24878 (NP-tr-1883) EXPERIENCE TO DATE WITH MARK IV FUEL ELEMENTS FITTED WITH DBF-4 GUIDE NOSES. Wolters (Kernforschungsanlage, Juelich (West Germany)). Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Aktennotiz Nr. 1/69 R2. 8p. Dep. CFSTI (U. S. Sales Only).

The performance in FRJ-2 Reactor of Mark 4 fuel elements with DBF-4 spacing guides is described. Required fuel element modifications for the DBF-4 spacing guides are presented. (D.C.C.)

24879 (ORNL-TM-1473) ALGORITHM FOR CALCULATING REACTIVITY FROM NEUTRON FLUX USING AN ON-LINE DIGI-

TAL COMPUTER. Lawrence, B. R.; Bullock, J. B. (Oak Ridge National Lab., Tenn.). 8 Apr 1970. 19p. Dep. CFSTI.

An algorithm of calculating reactivity from ϕ and $d\phi/dt$ was derived for use on an on-line digital computer for the High Flux Isotope Reactor. A space-independent reactor kinetics model was used. The algorithm was tested on a general purpose digital computer using noise-free numerical flux traces. The results, which are applicable to a broad class of thermal reactors, show the effects of different integration step lengths and of neglecting $d\phi/dt$ on the calculated reactivity. (auth)

24880 (ORNL-TM-1639(Pt.1)) MAINTENANCE MANUAL FOR THE HFIR INSTRUMENTATION AND CONTROL SYSTEMS. PART I. INTRODUCTION. Rubel, P. (Oak Ridge National Lab., Tenn.). 2 Mar 1970. 27p. Dep. CFSTI.

Because the normal high power density in the core of the High Flux Isotope Reactor approaches burnout conditions much more closely than other reactors, greater responsibility is placed on the instrument and control systems to avoid damage to the reactor. Three clearly defined instrument systems provide the necessary control and protection functions. These are: the wide-range counting channels, the regulating or servo channels, and the safety channels. Each of these systems is automatically keyed or adjusted for particular modes of reactor operation. In addition to the above systems, many of the process parameters (water flow, temperature, etc.) are monitored and regulated at predetermined setpoints by automated control instruments. The instrument and control systems are described. An index to other reports giving detailed maintenance information on individual systems is included. (auth)

24881 (ORNL-TM-2787) DEVELOPMENT OF AN AUTOMATIC RESTART SYSTEM FOR THE HFIR DIGITAL CONTROL AND DATA ACQUISITION SYSTEM. Owens, G. R. (Oak Ridge National Lab., Tenn.). 9 Feb 1970. 27p. Dep. CFSTI.

An automatic computer restart system was designed to restore the computer to operation after an electrical power failure or an internal fault interruption. Software was developed to restore the computer operating system to routine use with all real-time parameters updated properly. Hardware was developed to turn the computer on automatically after an electrical power outage and to place the restart programs into execution. The reactor operator is permitted access to computer information and reactor control programs quickly after an interruption of computer operation. (auth)

24882 (ORNL-TM-2788) DEVELOPMENT OF A MASS MEMORY PROGRAM EDITOR FOR THE HFIR DIGITAL CONTROL AND DATA ACQUISITION SYSTEM. Owens, G. R. (Oak Ridge National Lab., Tenn.). 9 Feb 1970. 43p. Dep. CFSTI.

Developing and debugging new software for the High Flux Isotope Reactor computer had required excessive time to edit source programs. Repetitive tape-punching by a slow paper-tape punch unit during editing was the major hindrance. A new editing scheme was developed to use the high-speed, mass memory drum unit for editing in lieu of the paper-tape punch. The computer software was modified to provide direct compilation and assembly of programs located in the mass memory editing area. This new technique allowed program errors to be eliminated prior to punching a paper tape. Software development was accelerated by using the faster program editing method. (auth)

24883 (ORNL-TM-2838) GRAPHICAL DISPLAY PROGRAMS FOR THE HFIR DIGITAL CONTROL AND DATA ACQUISITION SYSTEM. Danforth, H. P.; Owens, G. R. (Oak Ridge National Lab., Tenn.). 9 Feb 1970. 45p. Dep. CFSTI.

Three types of graphical display programs were prepared for the HFIR computer system: playback of process variables with several time-scale options, plotting of data stored in the mass memory by a multichannel high-speed input subsystem, and plotting of frequency-dependent, logarithmic, power spectral density data from neutron fluctuation analysis. The functional and operational descriptions of these programs and the plotting calibration routines are included along with block diagrams and assembly language program listings. (auth)

24884 (ORNL-TM-2914) BULK SHIELDING FACILITY QUARTERLY REPORT, OCTOBER, NOVEMBER, AND DECEMBER OF 1969. Tabor, W. H.; Hurt III, S. S.; Nixon, T. B. (Oak Ridge National Lab., Tenn.). 6 Mar 1970. 47p. Dep. CFSTI.

Operations and maintenance requirements for the Bulk Shielding Facility during October to December 1969 are presented. Experimental programs are reviewed. (D.C.C.)

24885 (ORNL-TM-2955) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, OCTOBER, NOVEMBER, AND DECEMBER OF 1969. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). 20 Mar 1970. 68p. Dep. CFSTI.

Operations and maintenance requirements during October to December 1969 are described. Experiments and testing programs are reviewed. (D.C.C.)

24886 (WAPD-TM-932) A COMPARISON OF THERMAL NEUTRON ACTIVATION MEASUREMENTS AND MONTE CARLO CALCULATIONS IN LIGHT-WATER-MODERATED URANIUM CELLS. Volpe, J. J.; Hardy, J. Jr.; Klein, D. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar 1970. Contract AT(11-1)-Gen-14. 38p. Dep. CFSTI.

Thermal disadvantage factors and spectral indices have been measured in a variety of lattices. One series contained slightly enriched uranium rods in hexagonal geometry; another used natural uranium fuel in slab geometry. Both types employed water as the moderator. The detectors used were ^{164}Dy, ^{176}Lu, and ^{239}Pu. Full energy range (0 to 10 MeV) Monte Carlo calculations with explicit cell geometry representations were performed using the RECAP program. In addition, thermal energy range (0 to 0.625 eV) calculations were obtained with the Monte Carlo program MARC as well as with the integral transport theory code THERMOS. The purpose of these investigations was to test the adequacy of the various water scattering kernel models — Nelkin, Koppel, and Haywood — for a broad range of thermal flux characteristics: from a soft moderator spectrum with a steep spatial gradient to a very hard spectrum which was relatively flat as a function of position. Conclusions are presented. (21 references) (auth)

24887 AN ABSOLUTE DOSIMETRIC CALIBRATION OF VK-3 AND VK-7 EXPERIMENTAL HOLES OF THE RA REACTOR WITH THE USE OF CALORIMETERS. Bod, Laszlo (Central Research Inst. for Physics, Budapest); Radak, Branislav. Bull. Boris Kidric Inst. Nucl. Sci., Chem.; 20: No. 2, 9-15(May 1969).

The experimental holes VK-3 and VK-7 of the RA reactor were calibrated dosimetrically using calorimeters of the heat-flow type in a differential measurement divided in stages. Two sets of measurements were performed in the following materials: graphite, water, solid oxalic and malonic acids, polyethylene, polystyrene. The self-consistency of the results is shown by cross-checking. Results are compared to the ones obtained by the calorimetrically calibrated chemical dosimeter (aqueous oxalic acid). The necessity of the calorimetric monitoring of reactor power was pointed out and its usefulness demonstrated. (5 references) (auth)

24888 CRITICAL EXPERIMENTS AND ZERO-POWER MEASUREMENTS WITH THE CRITICAL FACILITY "RAKE" FOR THE POWER LEVEL INCREASING OF THE RFR REACTOR. Endler, A. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernergie; 13: 6-11(Jan 1970). (In German).

The results are presented of critical experiments using the fuel elements E-CH 1 provided for the power level increasing of the RFR reactor. A description of both the structure and the optimization of a working charge is included. The zero-power experiment data necessary for the start-up of the power reactor are analyzed. 5 references. (auth)

24889 DETERMINATION OF REACTIVITY AND PSEUDO-REACTIVITY PERTURBATIONS IN VARIOUS CONFIGURATIONS OF THE ROSSENDORF ANNULAR CORE REACTOR RRR. PART I: GLOBAL PILE-OSCILLATOR MEASUREMENT OF REACTIVITY AND PSEUDO-REACTIVITY PERTURBATIONS. Faehrmann, K.; Huettel, G.; Liewers, P. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernergie; 13: 11-16(Jan 1970). (In German).

Using the pile-oscillator technique the reactivity effects of a thermal absorber (Mn sample) and the pseudo-reactivity effects of a fast neutron source (Ra(α,n)Be source; $Q = 2.64 \times 10^6$ s^{-1}) have been determined in the center of various experimental lattice configurations of the RRR reactor. Both measuring devices and evaluation method are described. The features of oscillator measurements by neutron sources are pointed out. It is shown how the influence ratio of fast and thermal neutrons at the location of the sample can be determined by an additional activity measurement of the Mn absorber in order to find its absorption rate. The evaluation of reactivity and pseudo-reactivity effects as well as of the influence ratios is described on the basis of one-dimensional multigroup diffusion calculations. 9 references. (auth)

Rocket and Space Reactors

24890 (AI-AEC-12925) S8DR ACTUATOR. Final Report. Donelan, L. E. (Atomics International, Canoga Park, Calif.). 15 Mar 1970. Contract AT(04-3)-701. 37p. Dep. CFSTI.

High-temperature, radiation-resistant, rotary actuators have been developed for use in the control system of SNAP reactors. These actuators are electromagnetic, variable reluctance, stepping devices with integral, spring-loaded brakes. Five actuators were built, and four of these have been tested successfully to the environmental and performance requirements of the SNAP 8 Development Reactor (S8DR) Program. These tests have been concluded; the final results are presented. The five actuntors were modifications of the originally designed units. These modifications were made as a result of design margin tests which were conducted at 1125°F (100°F above maximum design temperature). The results of the design verification tests that were conducted on the modified actuator are included. The results of the tests indicate that the modified actuators meet all environmental and performance requirements for the S8DR Program. 5 references. (auth)

24891 (LA-4324) FABRICATION OF PEWEE NOZZLES. Turner, W. C. (Los Alamos Scientific Lab., N. Mex.). Nov 1969. Contract W-7405-eng-36. 27p. Dep. CFSTI.

The methods used in developing a process for brazing U-type cooling tubes to the nozzle shell of a Pewee reactor are described. The selection of an Au-Ni-Pd brazing alloy, the development of special fixturing, the use of a vacuum brazing atmosphere, and the evolution of a situable method for applying the braze alloy are discussed. Two nozzles have been manufactured by applying these greatly improved brazing techniques. (auth)

24892 (UCRL-50459) CONCEPTUAL DESIGN OF A 2000 kW NUCLEAR HEAT SOURCE SUITABLE FOR SPACE ELECTRIC POWER. Pitts, J. H.; Walter, C. E. (California Univ., Livermore. Lawrence Radiation Lab.). 20 Jun 1968. 36p. Dep. CFSTI.

A conceptual design of a 2000 kW(t) Rankine system for nuclear-electric space power is described. The system includes a unique reactor-boiler unit operating at 1500°K that utilizes heat pipes in lieu of a conventionally pumped primary loop. An efficient heat pipe radiator rejects waste heat at 1035°K. Overall system efficiency is 18.8% yielding a net electrical output of 375 kW. The system specific mass is 10 g/W including a generous shadow shield for unmanned payloads. 25 references. (auth)

24893 FUEL ELEMENT FOR USE IN THERMIONIC NUCLEAR REACTORS. Busse, Claus-Adolf (to EURATOM). British Patent 1,185,583. 25 Mar 1970. Priority date 14 Apr 1967, Luxembourg.

NUCLEAR AUXILIARY POWER SYSTEMS—fuel elements for thermionic, design parameters of parallel arranged heat pipe connected

REACTOR FUEL ELEMENTS—design parameters of parallel arranged heat pipe connected thermionic (D.C.C.)

24894 CONCEPTUAL DESIGN OF A 10-Mw, NUCLEAR RANKINE SYSTEM FOR SPACE POWER. Pitts, John H.; Walter, Carl E. (Univ. of California, Livermore). J. Spacecraft Rockets; 7: 259-65(Mar 1970).

The conceptual design of a 10-MW(e) Rankine system for nuclear-electric space power is described. A compact nuclear reactor operating at 1650°K (~2500°F) uses UN as the fuel, Li as the coolant, and W-25% Re as a structural material. The reactor is controlled by a dual control system consisting of ^{6}Li liquid control tubes and a movable Mo side reflector. A LiH and W nuclear shield, which reduces radiation to an acceptable dose for a manned payload over a 10,000-hr life, is provided. The shield accounts for about half the total system specific mass of 7 kg/kW(e). A lightweight heat-pipe radiator rejects waste heat at 1100°K (~1500°F). Over-all system efficiency is 17.5%. (auth)

24895 REACTORS FOR SPACE. Fraas, A. P. (Oak Ridge National Lab., Tenn.). pp 1-23 of Recent Advances in Engineering Science. Vol. 4. /Eringen, A. C. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From 5th Meeting on Recent Advances in Engineering Science, Huntsville, Ala. See CONF-671091.

The relative costs and hazards problems of isotopes and nuclear fission reactors are compared, and the major advantages of the latter for the larger size units are shown. Some of the problems and limitations of thermoelectric units and thermionic cells that are not generally appreciated are pointed out, and various thermodynamic cycles for use with turbine-generator units are reviewed. From this, coupled with a brief review of both the requirements for space power plants and the characteristics of possible power sources, it is deduced that a nuclear fission reactor coupled to a potassium Rankine cycle system provides the most attractive nuclear system for space applications where large amounts of power are required. The engineering problems involved in the choice of working fluids, structural materials, and fuel elements are reviewed and operating experience is cited to indicate that the system is feasible. Some of the problems of design of reactors, turbines, pumps, boilers, and condensers are discussed, and Oak Ridge National Laboratory studies of integration of these components into one-, two-, and three-loop systems are summarized. 10 references. (auth)

24896 SHIELD MASS OPTIMIZATION OF A NUCLEAR SPACE VEHICLE. Pepper, Joe W. (Florida State Univ., Tallahassee). AIAA (Amer. Inst. Aeronaut. Astronaut.) Stud. J.; 7: 185-7(Oct 1969). (CONF-680467-1).

From American Institute of Aeronautics and Astronautics, Southeastern Regional Student Conference, Atlanta, Ga.

The problem of shielding the occupants of a low-thrust nuclear-powered space vehicle against any harmful radiations from the reactor is analyzed. It is assumed that there exists a particular combination of distance shielding and material shielding that will provide a minimum mass and still reduce the radiation to a tolerable level. The objective is to find this optimum position. An expression for the attenuation of radiation from a point source is found and substituted, as an internal constraint, into the expression for the total mass of the shielding combination. This total mass equation is differentiated and set equal to zero, giving an optimum shield thickness of approximately 1.5 ft of lead. (auth) (IAA)

24897 PLASMA-JET ENGINE. Mason, Michael David Lawrence. British Patent 1,185,360. 25 Mar 1970. Filed 18 Aug 1967.

Reference is made to an engine to propel an air-breathing nuclear powered aircraft. The aircraft would carry a power pack consisting of a fast breeder reactor and turbo-alternator equipment to produce electrical energy and the separate air-breathing plasma jet engine would use the electrical energy to generate thrust to propel the aircraft. Details are given of the energy conversion process, electrical to chemical energy conversion, chemical to heat energy conversion, and heat energy to thrust. The principle is to employ the electrical energy from the reactor/turbo-alternator system to create a silent discharge of electrons which bombard the air flow in the air-breathing engine, the kinetic energy of the bombarding electrons being converted into heat energy in the air flow, after intermediate chemical reactions of the air molecules; thrust is obtained by expanding the heated air flow through a propulsion nozzle. (UK)

Process Heat and Desalination Reactors

24898 ATOMIC ENERGY CENTER AND INDUSTRIAL COMPLEX. Ito, A. (Kyushu Electric Power Co., Inc., Fukuoka). Genshiryoku Kogyo; 16: No. 1, 42-6(Jan 1970). (In Japanese).

With the advance of multi-purpose reactors, the idea has emerged recently of combining an atomic energy center, i.e., a central power station, and an industrial complex. This is necessary in Japan because of the energy sources available in the country and of other industrial considerations. The developments in various countries of the world are reviewed. The introduction of nuclear reactors into the chemical industry, for desalting water, for iron manufacture, for heating housing, and an atomic energy center and an agro-industrial complex are described. Finally, the envisaged evolution of the combined atomic energy center and industrial complex in Japan is explained. The basis of this particular idea is the efficient utilization of basic energy sources, i.e., electricity, water, and steam, in an industrial complex. Electronic computers are employed for plant control. Among the industries in the complex are those of fertilizer, petrochemistry, metal, textile, and food. (NSA of Japan)

Marine and Portable Power Reactors

24899 SAFETY DEVICE AGAINST OVERHEATING OF THERMIONIC ELEMENTS HEATED BY NUCLEAR ENERGY. (Brown Boveri and Cie Aktiengesellschaft). British Patent 1,187,109. 8 Apr 1970. Priority date 9 Dec 1966, Germany.

NUCLEAR AUXILIARY POWER SYSTEMS—fuel elements of, description of melting plug released safety gas coolant for thermionic

REACTOR FUEL ELEMENTS—safety gas coolant for thermionic, description of melting plug released (D.C.C.)

24900 DESIGN OF A CONTROL ROD DRIVE MECHANISM FOR A MARINE PRESSURIZED WATER REACTOR. Hofman, J. Atoomenergie Haar Toepass.; 11: 15-18(Jan 1969). (In Dutch).

Design studies for a control rod drive mechanism for the NERO project were started during the Spring of 1966. Production began in 1967; during the same year the testing system was completed. In order to eliminate leakage problems, no mechanical control components will penetrate the pressure vessel's wall; instead, the rod inside of the wall will be displaced by means of a magnetic clutch and the position of the rod will be indicated by means of magnetic switches and synchro systems. A hydraulic scram mechanism with electromagnetic braking will check the involuntary escape of the rod from the core. Design specifications and mechanical details of the system are reviewed together with construction of the sub-system components. (TTT)

24901 HEALTH PHYSICS IN THE FIRST NUCLEAR SHIP. Kawai, Yasuhiko (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 72, 1829-36(Oct 1969). (In Japanese).

The reactor for the Mutsu nuclear ship is a pressurized water reactor. The radiation shield is composed of a primary shield and a secondary shield. The reactor room and engine room are designated as the controlled area, the area giving access to the controlled area is designated as the peripheral watch area, and all the rest is the safe area. For the measurement of dose for men, film badges, pocket dosimeters and glass dosimeters are used together. Radiation monitors are classified into fixed area monitors, monitors for gas, dust and water, and portable meters for survey and sampling. As for the radioactive waste produced in the ship, gas is exhausted in the atmosphere, while liquid and solid waste are stored in the ship, unloaded at the home port, and processed afterwards. Protective clothes and others are not decontaminated in the ship. Duplicate precautions are taken against collision, stranding, flooding, sinking, fire and explosion, so as such accident does not cause reactor trouble. A safety analysis was carried out for a reactor accident with the loss of primary coolant. (NSA of Japan)

Production Reactors

Refer also to abstracts 22848 and 24720.

24902 (DUN-6359) N REACTOR SYSTEMS OPERABILITY. Status Report. Leventis, A. A.; Bruce, R. A.; Garcia, I. M. A. (Douglas United Nuclear, Inc., Richland, Wash.). 25 Oct 1969. Contract AT(45-1)-1857. 15p. Dep. CFSTI.

An evaluation directed at appraising the N Reactor operability is presented so that availability and reliability goal allocations for those systems which have potential for shutting down the reactor are analyzed. It is intended that these goals be applied to technical criteria and bases, and will also give part of the background required for recommendations for allocation of maintenance resources to solve long term N Reactor problems. 6 references. (auth)

24903 RELIABLE POWER FOR HANFORD. Budd, J. H. Power Eng.; 74: 49-52(Mar 1970).

The electric power supply system for the Hanford Production Reactors is described. Maintenance and testing programs for the power system are reviewed. (D.C.C.)

Reactor Theory

Refer also to abstracts 23037 and 23038.

Kinetics

Refer also to abstracts 24812, 24813, 24877, and 24879.

24904 (LFEN-NI.-42-a) NEUTRON DIFFUSION IN SUBCRITICAL ASSEMBLIES. Jorge, H. Machado; Salgado, J. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 31p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The development of the scattering theory is given, presenting first a detailed study of the processing of the one-group theory and then the processing of the two-group theory. The results of the two-group theory are applied to the study of subcritical assemblies. (tr-auth)

24905 APPROXIMATION OF AN INTEGRAL APPEARING IN A LOSS OF COOLANT ACCIDENT CALCULATION. Milman, Y (Soreq Nuclear Research Centre, Yavne, Israel). Israel J. Technol.; 7: 269(1969).

24906 METHOD TO CALCULATE COLLISION PROBABILITIES IN CLUSTERS. Bollacasa, D.; Bonalumi, R. A. (CISE, Milan). Energ. Nucl. (Milan); 17: 244-8(Apr 1970).

A new semianalytical method to calculate collision probabilities in cluster geometry is presented. This method has been compared with a purely numerical method and has yielded very good results. (auth)

24907 ESTIMATION OF THE DYNAMIC REACTIVITY USING DIGITAL KALMAN FILTERING. Venerus, Joseph C. (Knolls Atomic Power Lab., Schenectady, N. Y.); Bullock, Thomas E. Nucl. Sci. Eng.; 40: 199-205(May 1970).

The problem of computing the time-dependent reactivity from flux measurements is solved for a stochastic-point-reactor model using linear estimation theory. In order to use this method, an appropriate reactivity model must be formed which can be embedded into the reactor system as one of its state variables. A digital filter, designed using Kalman-Bucy filter theory, operates on the sampled neutron-density output of the stochastic reactor and provides estimates of the state variables of the system, one of which is the reactivity. Digital computer results are used to show the response of the Kalman filter in computing the reactivity from stochastic-neutron-density measurements. The results show that this analytical filter can be used to determine the reactivity from neutron density which has a certain noise content due to the stochastic processes involved in the reactor system. (10 references) (auth)

24908 POINT SOURCE GREEN'S FUNCTIONS FOR NEUTRAL PARTICLE TRANSPORT. Meyer, James F.; Jacobs, Alan M. (Pennsylvania State Univ., University Park). Nucl. Sci. Eng.; 40: 239-45(May 1970).

Expressions for point source Green's functions are developed which mathematically describe monoenergetic, neutral particle transport in uniform, unbounded media with particle absorption and azimuthally symmetric scattering of finite-degree polar angle anisotropy. The method of development follows closely the plane source superposition technique of Fano, Spencer, and Berger with the extension of explicit formulation of the relevant plane symmetry functions. Some limit properties of the derived Green's function are considered. (13 references) (auth)

24909 INTEGRAL TRANSFORM METHOD FOR NEUTRON TRANSPORT PROBLEMS. Hembd, H. (EURATOM-CCR, Ispra, Italy). Nucl. Sci. Eng.; 40: 224-38(May 1970).

A new method for the solution of the Boltzmann equation for time-dependent or stationary neutron transport is presented. The essentials of the method are a Fourier transform of the transport integral equation and the decomposition of the new kernel into a bilinear form. In the monoenergetic case, the transport problem is reduced to the solution of an (infinite) linear system of equations. It is important that the matrix elements in this linear system be determined only once for any geometry and that this be done in an analytical way. The matrix elements for plane, spherical, and cylindrical geometries are constructed explicitly and are presented in a form suitable for numerical applications. To illustrate the efficiency of the method, the critical dimensions for these geometries have been determined in various integral transform IT_N approximations, N being the order of the linear system after truncation. For samples of a thickness up to ~10 mean-free-paths, the results for the critical dimension in stationary problems, or for the fundamental time-decay constants in nonstationary problems, have in the IT_4 approximation, at least, the accuracy of the corresponding S_{16} results. The convergence of the IT_N results, with respect to the order N, is very fast. The results for N = 4 can be considered as exact within one or two units in the fifth digit. The convergence behavior of the S_N and the P_N method is decidedly slower. In contrast to the S_N, P_N or Case's method, the smaller the system, the better the accuracy of the IT_N calculations for fixed N is. The increase in accuracy by increasing N requires less computational effort for the IT_N approximation than for S_N or P_N approximation. Apart from providing an analytical standard for the check of numerical approximations, the present method is a simple and rigorous tool for the calculation of neutron distributions, particularly in small systems. (auth)

24910 MEASUREMENTS AND DETAILED MODEL ANALYSIS OF SPACE-CORRELATED REACTOR FLUCTUATIONS. Harris, D. R.; Natelson, M.; Galey, J. A.; Schmidt, E. (Bettis

Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng.; 40: 173-98(May 1970).

Correlated neutron fluctuation experiments have been performed on a poorly coupled, multiple seed-blanket reactor and on a better coupled cylindrical lattice reactor. The fluctuating numbers of counts recorded in various gate times by separated detectors are analyzed in terms of a proposed measure of reactor coupling, the modified coefficient of correlation, MCC, as well as in terms of the conventional dispersion parameter Y. Effects of count losses, statistical bias, and statistical error are examined. Calculations of MCC and Y are carried out in the α-mode form of the product density formalism for a number of detailed reactor models, including several four-energy-group diffusion theory and P-3 transport models for reactor design. Two of these detailed models, incorporating reduced fast-neutron transport and removal cross sections, are in agreement with MCC measurements, while one design model is not. 32 references. (auth)

24911 AN ANALYTIC METHOD FOR THE CALCULATION OF THE SPACE- AND ENERGY-DEPENDENT SPECTRA AND THE INTEGRAL PARAMETERS OF THERMAL REACTOR LATTICES. Liu, Yiu-sing. Urbana, Ill.; Univ. of Illinois (1969). 107p.

Thesis.

An analytic method is developed for solving the space- and energy-dependent Boltzmann equation in the P_n approximation for the neutron flux in a slab lattice cell. The disadvantage factors obtained using this method are more accurate than the results of Honeck's multigroup transport calculations for slab lattices of 1.25% enrichment. In the method presented, the neutron energy is divided into two regions, namely, the thermal and epithermal regions. In the epithermal region Wick's short-collision-time approximation is employed for the differential scattering cross section of the moderator, and the epithermal flux is expressed in terms of a power series. The epithermal flux is then multiplied by a factor g(E). This product serves as a source term in the thermal region and approaches zero as the energy decreases. The Boltzmann equation for the thermal flux is then solved by expanding the thermal flux and the source term in terms of a set of biorthonormal functions. The first n angular moments of the scattering kernel are used for the moderator in the thermal region. The method presented gives accurate integral parameters and neutron spectra at various spatial points for lattices of up to 5% enrichment. (Diss. Abstr.)

24912 IMPROVEMENTS IN THE MULTIPLE COLLISION METHOD. Hoertner, H.; Putz, F. (Institut fuer Reaktortechnik, Vienna). Atomkernenergie; 15: 87-90(1970).

The multiple collision method was used for calculating the thermal utilization factor in slab lattices. The errors arising from the usual assumptions were investigated. In order to improve the method a first order approximation of the anisotropic neutron angular distribution was considered; furthermore, the exact formulae for the second collision probabilities were taken into account. For the higher order collision probabilities the asymptotic expressions for an infinite number of collisions were used. The results of numerous numerical calculations are summarized. (14 references) (auth)

24913 A METHOD FOR COMPUTATION THE SPACE AND TIME DEPENDENT POWER DISTRIBUTION IN NUCLEAR REACTORS. Birkhofer, A.; Werner, W. (Technische Hochschule, Munich). Atomkernenergie; 15: 97-102(1970). (In German).

An explicit method is described to solve the multigroup time dependent diffusion equation by using two time levels. The method is numerically stable for any time step. A variant of the same method can be used very effectively for the computation of the steady state initial flux distribution. The described model is written in two dimensions with six groups of delayed neutron and Doppler feedback. (4 references) (auth)

Dynamics

Refer also to abstract 24811.

24914 WEIGHTED-RESIDUAL METHODS IN SPACE-DEPENDENT REACTOR DYNAMICS. Fuller, E. L. (Argonne National Lab., Ill.); Meneley, D. A.; Hetrick, D. L. Nucl. Sci. Eng.; 40: 206-23(May 1970).

Approximate methods for the solution of problems in space-dependent nuclear reactor dynamics are analyzed. It is shown that these approximate methods can all be considered applications of the method of weighted residuals. In each method, a trial solution is formed for the neutron flux by making expansions in known spatially dependent functions called trial functions. Each approximate method differs from the others in the manner in which its trial functions are chosen. The undetermined time-dependent functions, called amplitude functions, are then found by using the weighted-residual procedure known as the method of undetermined functions to derive the so-called multimode kinetics equations, which are first-order ordinary differential equations in time. The multimode kinetics equations are then integrated using the method of undetermined parameters. Weighted-residual procedures are thus used for both spatial and temporal integrations. Some numerical results are reported for continuous synthesis and multichannel synthesis approximations. Several choices of weighting functions are compared. Conclusions are drawn regarding the roles of the trial functions and the weighting functions in obtaining accurate solutions. (33 references) (auth)

Experimental Applications

Refer also to abstracts 24814, 24830, 24871, 24873, 24874, 24886, 24920, 24930, and 24931.

24915 STUDY OF THE USE OF PULSED-NEUTRON EXPERIMENTS ON MULTIPLYING LATTICES FOR THE ADJUSTMENT OF CRITICALITY CODES. Deniz, V. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Sci. Eng.; 40: 246-53(May 1970).

Criticality codes are in general adjusted to reproduce measured values of critical bucklings which furnish $(k_\infty - 1)/M^2$. The parameter adjusted is k_∞, the calculation of leakage being assumed to be well made. However, in the case of heterogeneous systems in particular, the slowing down region is not easy to study, and one has perforce to make certain simplifying assumptions which reflect on the calculated value of age. Since a proper estimation of leakage is necessary for a code adjusted on clean critical systems to be valid when extrapolated to large power reactors where leakages are different, it is of practical interest to be able to use some experimental data for checking age calculations and searching for improvements if necessary. Pulsed experiments furnish the necessary experimental data, since measurements made on a given lattice for different block sizes permit the separation of multiplication from leakage. A method of analysis is presented and applied to experiments on natural uranium/graphite lattices. An effective age-diffusion expression in which k_∞/p, L^2 and the mean lifetime l_0 are evaluated in terms of buckling-dependent spectra, is transformed into a linear equation which permits simultaneous adjustment of p and of the age. Analysis shows that pulsed experiments can be sufficiently precise for age adjustments. However, since these experiments are performed at far-from-critical bucklings, the precision is not sufficient for adjusting p, and hence k_∞. These experiments are very useful for adjusting leakage, but this adjustment being made, critical experiments remain necessary for the subsequent adjustment of k_∞ with precision. (11 references) (auth)

24916 DETERMINATION OF REACTOR PARAMETERS BY SINGLE ROD EXPERIMENTS. Raisic, Nenad; Zdravkovic, Zoran; Ivkovic, Magdalena; Sotic, Obrad. Bull. Boris Kidric Inst. Nucl. Sci., Nucl. Eng.; 20: No. 2, 9-16(May 1969).

A method is developed for the experimental determination of reactor parameters by using an isolated fuel element. The method is based on the consideration of the fuel element as the source and sink of neutrons when placed in a constant neutron field. By measuring the perturbation of the original field produced by insertion of the test fuel element is was possible to determine the fuel element parameters defined by the heterogeneous reactor theory of Feinberg and Galanin as thermal neutron absorption constant γ, and neutron multiplication constant η. Statistical error for one series of measurement amound to 2% in the values of η and γ. The developed method was intended for the analysis of the nuclear characteristics of the fuel element in the stage of its construction and development for a given reactor system. (8 references) (auth)

24917 ANALYSIS OF THE TEMPERATURE FIELD IN A REACTOR FUEL ELEMENT OF COMPLEX GEOMETRY. Spasojevic, Dusan; Vehauc, Aleksandar. Bull. Boris Kidric Inst. Nucl. Sci., Nucl. Eng.; 20: No. 3, 17-24(June 1969).

An effective analytical method for determining the steady integral thermal conductivity and temperature distributions in cluster fuel elements has been developed. This method takes into account: the distribution of heat generation, given by a nonsymmetric function over the fuel rod cross section, $q = q(r,\phi)$; the thermal conductivity of the fuel and cladding material dependent on temperature, $\lambda = \lambda(t)$ and $\lambda_k = \lambda_k(t)$; and the fuel element cooling conditions defined by the boundary conditions of the first, second or third kind. The application of the developed method to a given fuel element is presented. (7 references) (auth)

24918 MONTE CARLO ANALYSIS OF PERTURBATIONS IN FAST REACTORS WITH APPLICATIONS TO DOPPLER COEFFICIENTS. Mueller, Charles. Evanston, Ill.; Northwestern Univ. (1969). 124p.

Thesis.

A stochastic method has been developed to analyze the effect of cross section perturbations in a fast reactor with one computer application of only one set of random numbers. The procedure consists of using the same flight paths and collision points for one unperturbed system and any number of perturbed systems. With the applications of certain weighting techniques nuclear events are recorded simultaneously for all these systems. A Monte Carlo code has been written to analyze a fast reactor system at several temperatures simultaneously. This code was used to analyze certain Doppler coefficient studies made by the Argonne National Laboratory in the ZPR-6 fast critical assembly. The results obtained from the Monte Carlo analysis are in good agreement with the experimentally obtained results. The code was also used to study the effect of different fuel enrichments and Na volume fractions on the Doppler coefficient in a large carbide-fuel fast reactor. The code can also be used to extend already existing Doppler coefficient curves into temperature ranges beyond the reach of experiment. (Diss. Abstr.)

24919 A METHOD FOR THE DETERMINATION OF VARIOUS NUCLEAR REACTOR PARAMETERS FROM COUNTING TUBE SIGNALS. Krause, H. D. (Institut fuer Mess-Regelungstechnik, Munich). Atomkernenergie; 15: 103-8(1970). (In German).

A method is described which allows the determination of the subcritical multiplication factor, the neutron lifetime, the detector efficiency, the fission rate and reactor power of a nuclear reactor from counting tube signals. The counting tube signals from a SIEMENS university training reactor (SIEMENS-Unterrichts-Reaktor) were analyzed with regard to the determination of various reactor parameters. On the SUR, measurements were made at subcritical states till criticality. A Ra-Be-neutron source of 10 mCi was situated in the center of the core, a BF_3-counter in a detector channel. All devices belonged to the normal operational instrumentation. The counting tube signal, whose counting rate must be known, was transformed by a flip-flop into a telegraph wave and recorded on a tape recorder. The power spectral density was computed in the well known manner with a bandpass filter and analog computer elements by multiplication and integration. In parallel to the analysis of the counting tube signals the spectral densities were computed by a digital computer on the basis of a special theory. In comparison with the counting tube spectra the various reactor parameters were found. For an α of 240 s^{-1} there yielded an error of ± 20 s^{-1}; this corresponds with a multiplication factor of 0.995 ∓ 0.001. The multiplication factor is affected with an error of about 1%. The values of the detector efficiency and also the reactor power, which were computed besides the multiplication factor and the fission rate, lay in good agreement with the expected values. Further on there were made measurements at the nuclear power station KRB, Gundremmingen. In the subcritical region of the power reactor, signals of three fission chambers were recorded. The theory of the method described is based on a reactor model which should explain the statistical properties of the detector output. With this model a hypothesis is coupled which interprets the counting tube signal as a random pulse sequence (neutron source, spontaneous fission), modulated with a signal with random amplitude (multiplicative chain process). Extending this hypothesis, the equivalence of the counting tube signal to an electrically generated pulse position modulation (PPM) is postulated. The correctness of the hypothesis is demonstrated by the coincidence of the measured power spectral densities with the theoretically computed densities. (9 references) (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 22855, 22917, 23422, 23428, 23438, 23441, 23450, 23479, 23497, 23498, 23501–23506, 23510, 23512, 23533, 23535, 23539–23541, 24103, and 24781.

24920 (WCAP-7426) IODINE REMOVAL IN THE ICE CONDENSER SYSTEM. Malinowski, D. D. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems [Div.]). Mar 1970. 86p.

The removal of gaseous elemental iodine from the vapor stream entering an ice condenser unit was studied for the effects of vapor composition, ice additives, ice loading, vapor temperature, flow channels, flow characteristics, and iodine concentration. It was found that alkaline additives enhance the retention of iodine in the ice melt by hydrolysis reactions which convert the iodine to nonvolatile, soluble forms of iodide and iodate. The effect of the iodine content in the steam/air mixtures at the levels studied was found to be small. The iodine removal was strongly influenced by the fraction of air in the steam/air vapor mixture; iodine retention did not exhibit a 1.1 correspondence to steam condensation in the presence of air. The observed pattern of data intended to demonstrate the effect of Reynolds number for bulk flow characteristics could be correlated into three air-flow-dependent curves. There was no visible dependence of the iodine retention on the range of equivalent diameters studied which included that of the ice condenser. Several tests using methyl iodide in place of elemental iodine indicated that the ice would not be an efficient means for removal of organic halides. 4 references. (auth)

24921 A FUEL AND BREEDING ELEMENT FOR NUCLEAR REACTORS. (to Kernforschungsanlage GmbH). British Patent 1,186,652. 2 Apr 1970. Priority date 17 Jan 1967, Germany.

REACTOR FUELS—design parameters of breeding and fissile materials coated particle (D.C.C.)

24922 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS. Bramfitt, Arthur Clive Ford; Hendry, Innes Craig (to United Kingdom Atomic Energy Authority). British Patent 1,184,086. 11 Mar 1970. Filed 15 Mar 1967.

The object of the fuel element described is to provide for localized high neutron fluxes in existing liquid cooled reactors. The fuel element comprises a central tubular member having plate-like lengthwise fins containing fuel material. The fins are at least in part non-radial with respect to a longitudinal axis of the tubular member and subtend at that axis angles of which the sum exceeds 360°, being offset at radially inward edges from the tubular member and at their radially outward edges being open over substantially the entire length of the array to the environment beyond these edges. This arrangement allows liquid coolant to pass over the fins with flow components which are both longitudinal and circumferential with respect to the tubular member. A specific application of this type of fuel element as a reactor neutron irradiation facility is described. (UK)

24923 IMPROVEMENTS IN OR RELATING TO CONNECTOR ASSEMBLIES FOR NUCLEAR REACTORS. Bradshaw, Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,184,391. 18 Mar 1970. Filed 11 Jul 1967.

Reference is made to the problem of providing electrical, pneumatic and other services to experimental equipment located within a reactor core. The space available for such service connections tends to be cramped, leading to difficulty with regard to ready connection to experimental rigs. The object of the system described is to provide an improved form of connecting arrangement whereby such difficulties are minimized. The system comprises a multipoint terminal assembly located on the component to which the services are to be connected, a multipoint terminal assembly statically mounted within the reactor and connected to the external services, and a unitary member arranged to bridge the two terminal assemblies. The component to be serviced may be tubular and may support an annular multipoint terminal ring, in which case the static portion may incorporate a second annular multipoint terminal ring, and the unitary member may comprise a tubular sleeve having two internally connected multipin terminal blocks mutually engageable with the terminal rings. The tubular sleeve is preferably provided with radial apertures adapted to interconnect a gas duct in the static assembly with a gas duct in the serviced component. By way of illustration the application of such a system to a materials testing fast reactor is described in detail. (UK)

24924 LINEAR MOTION DEVICE. (to Borg-Warner Corp.). British Patent 1,188,084. 15 Apr 1970. Priority date 22 May 1967, United States.

REACTOR CONTROL ELEMENTS—drives for, description of electric motor actuated concentric lead screw (D.C.C.)

24925 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Societe des Forges et Ateliers du Creusot). British Patent 1,189,054. 22 Apr 1970. Priority date 25 Jan 1967, France.

REACTORS—core support structures for, description of enclosed heat exchanger post type (D.C.C.)

24926 NUCLEAR REACTOR SUPPORT STRUCTURE. Faurot, Paul; Leclou, Andre (to Commissariat a l'Energie Atomique). British Patent 1,188,905. 22 Apr 1970. Priority date 24 Mar 1967, France.

REACTORS—core support structures for, description of concentric cylinders and graphite brick (D.C.C.)

24927 INVESTIGATION OF THE DISTRIBUTION OF HEAT TRANSFER ON FINS AND MODEL FINNED-TUBES. Krueckels, W.; Kottke, V. (Univ., Stuttgart). Chem.-Ing.-Tech.; 42: 355-62 (Mar 1970). (In German).

The distribution of heat transfer on plates having blunt incident flow edges, on single fins, and on model finned-tubes is investigated by measurements of material transfer. The analogy between heat transfer and material transfer permits calculation of the corresponding heat transfer coefficients from the photometrically measured distribution of the amounts of material transferred. It is shown that the incident flow edge plays a particularly important role in the transfer process. The distributions measured on the tube models can be used as a basis for the calculation of average heat transfer coefficients. Further, systematic investigations of the type mentioned can afford information regarding the design of optimal fin shapes. 17 references. (auth)

24928 LIMITATIONS OF THE ZERO-DIMENSIONAL GAP MODEL FOR THERMAL FUEL ELEMENT ANALYSIS IN CASE OF AN ECCENTRIC PELLET POSITION. Wolf, L.; Johannsen, K. (Technische Univ., Berlin). Atomkernenergie; 15: 147(1970).

For liquid-metal bonded fuel elements, the application of the zero-dimensional gap model does not seem permissible in view of the high thermal conductivity of liquid metals and relevant gap widths (in the order of magnitude of canning thickness) under consideration. Therefore, a thermal analysis taking into account the actual dimensions of the eccentric annular gap (two-dimensional gap model) by applying bipolar coordinates and point-matching technique was performed. Numerical results of this analysis are compared with those using the zero-dimensional gap model thus showing the limitations of the latter. (auth)

24929 A FINITE ELEMENT STRESS ANALYSIS OF THE VERTICAL BUTTRESSES OF A NUCLEAR CONTAINMENT VESSEL. Yang, Henry T. Y. (Gilbert Associates, Inc., Reading, Pa.). Nucl. Eng. Design; 11: 255-68(Mar 1970).

The results of a stress analysis of the vertical buttresses of a prestressed concrete nuclear containment vessel are presented. The computations were basically performed by a plane strain finite element computer program which employs the Gauss-Seidel iterative procedure to solve the 900 by 900 direct stiffness simultaneous equations. A subroutine for finding an optimum over-relaxation factor for accelerating the convergence rate has been developed which has reduced considerably the trial and error computing time needed for guessing such a factor. The loading conditions include prestress forces of hoop tendons and thermal forces of liner and concrete due to temperature gradients, which were the steady state and transient state solutions of heat distributions in the vessel wall and buttresses under winter normal operating and accident temperature conditions. For the winter accident temperature condition, cracks due to high tensile stresses were investigated. (7 references) (auth)

24930 A DISCRETIZED VARIATIONAL FORMULATION OF ANISOTROPIC SMALL STRAIN PLASTICITY PROBLEMS. Havner, Kerry S. (North Carolina State Univ., Raleigh). Nucl. Eng. Design; 11: 308-22(Mar 1970).

A general deformation theory of small elastic-plastic strains in an orthotropic material is presented together with a variational formulation and solution technique for the associated discretized plane strain problem. Quasi-linear difference equations are obtained through minimization of the discretized potential energy function, resulting in positive definite stiffness matrices (given appropriate constraints on the elastic and plastic parameters of the material). Alternate ways of organizing the iterative calculation steps for digital computer are discussed. In addition, an analytic stress path criterion for the orthotropic deformation theory is given, based upon the concept of a corner forming on the yield surface. (18 references) (auth)

24931 A LUMPED PARAMETER ELEMENT FOR THE ANALYSIS OF AXISYMMETRIC SOLIDS OF REVOLUTION. Mohraz, Bijan; Schnobrich, William C. (Univ. of Illinois, Urbana). Nucl. Eng. Design; 11: 333-4(Mar 1970).

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